POPULAR SCIENCE

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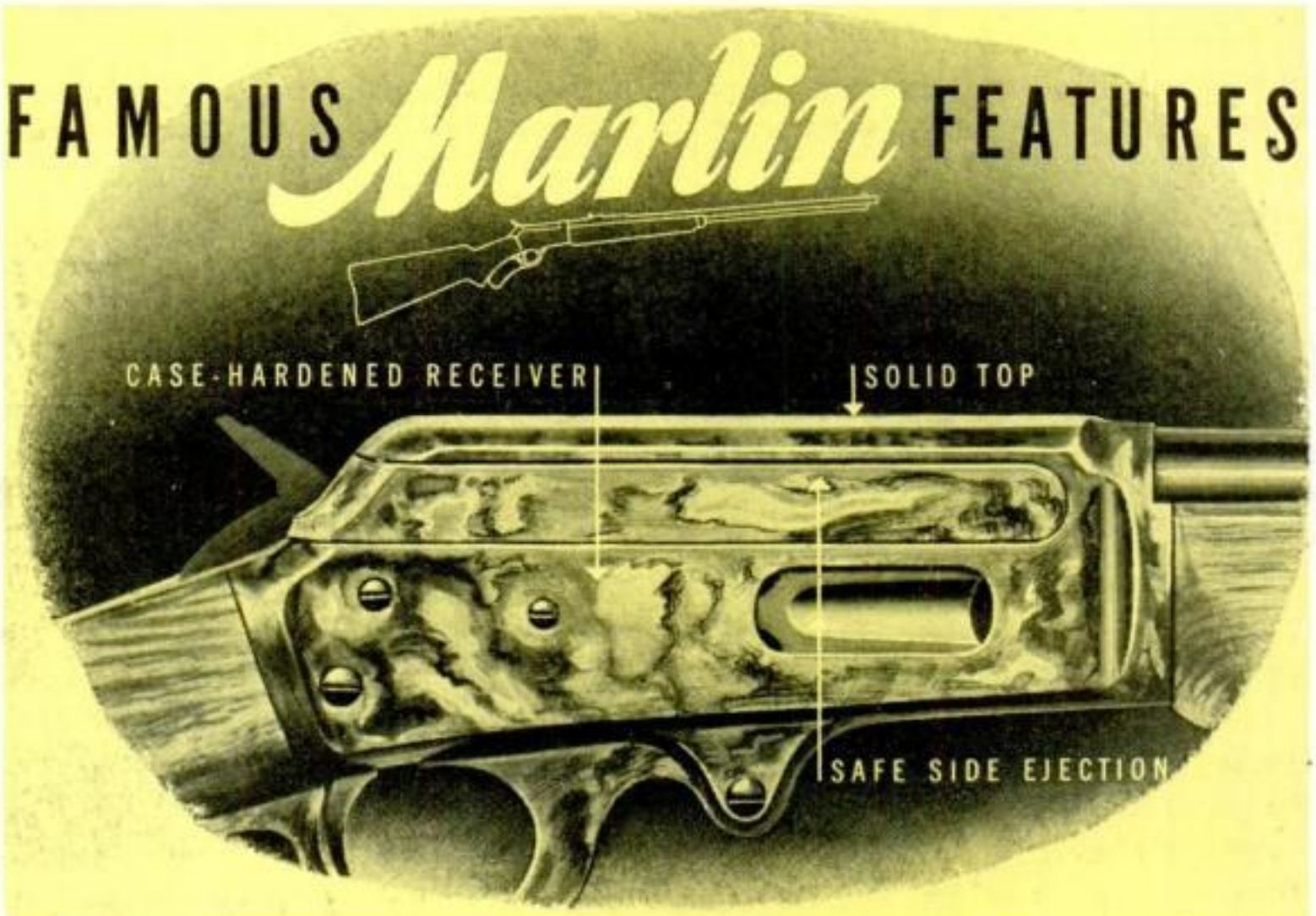
MONTHLY

VE DONT AGREE, MAJ. DE SEVERSKY CHAT OUR FIGHTING PLANES FAILED . . .

SEE PAGES 69-83

FAMOUS *Marlin* FEATURES



MARLIN big game rifles—as well as the famous lever action .22—have featured the solid top receiver and side ejector since their introduction by Marlin a half century ago.

These are the model 36's—carbine, sporting carbine and rifle in .30-.30 and .32 special calibers—and the model 39-A, only lever action .22 made and the only take-down rifle exposing all working parts by the turning of a single hand screw.

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FOUNDED 1872 MONTHLY VOL. 142 NO. 1

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

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BROWNING AUTOMATIC RIFLE. This fast-shooting shoulder arm is one of the large family of automatic weapons with which our fighting men are provided. The Axis can't tell us a thing about machine guns and similar weapons, because Yankee inventors and gunsmiths have been among the leaders in perfecting them. An article on page 124 traces the history of automatic weapons and describes the ones used by our Army, from the .45 pistol to the 40-millimeter cannon.

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A United States Marine dodges swiftly across the battle-scarred slope, takes position behind a shattered wall that commands the enemy gun emplacement across the tiny valley.

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The Marine speaks quietly into the tiny microphone in his hand. "AK9 to BJ. Left four zero. Two hundred short." Miles away, an American artillery officer issues swift commands to his gun crew.

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WAR

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INVASION BY SEA is one of the most difficult of military operations. What have we learned from the Japanese and the Germans, the modern experimenters in this field? An article describes the careful preparation and grueling drill that must precede the thrilling moment when the barges and landing boats head in through the dawn for the enemy beaches.

THE COOLING SYSTEM of your car is one of its most vital parts, and as such it deserves the very best care you can give it. Here is an article which, by means of photographs and charts, shows you at a glance just what can go wrong in a cooling system—and just what you can do to prevent it. If you're looking for a good way to keep your car healthy for the duration, don't overlook this expert advice.

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CHEMISTRY is now faced with its biggest job of finding new ways to make new things with new materials. And that doesn't mean merely poison gas and secret weapons. It means every conceivable object from a new type of landing field in a Malayan jungle to a new kind of shoelace tip. The chemists are in the war to win. Read about their efforts to get victory out of a test tube.

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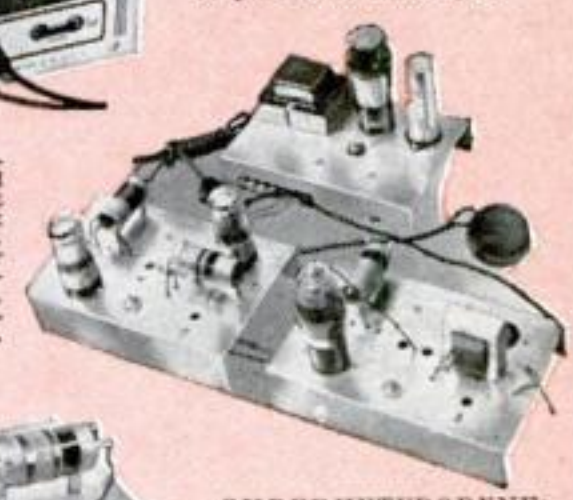

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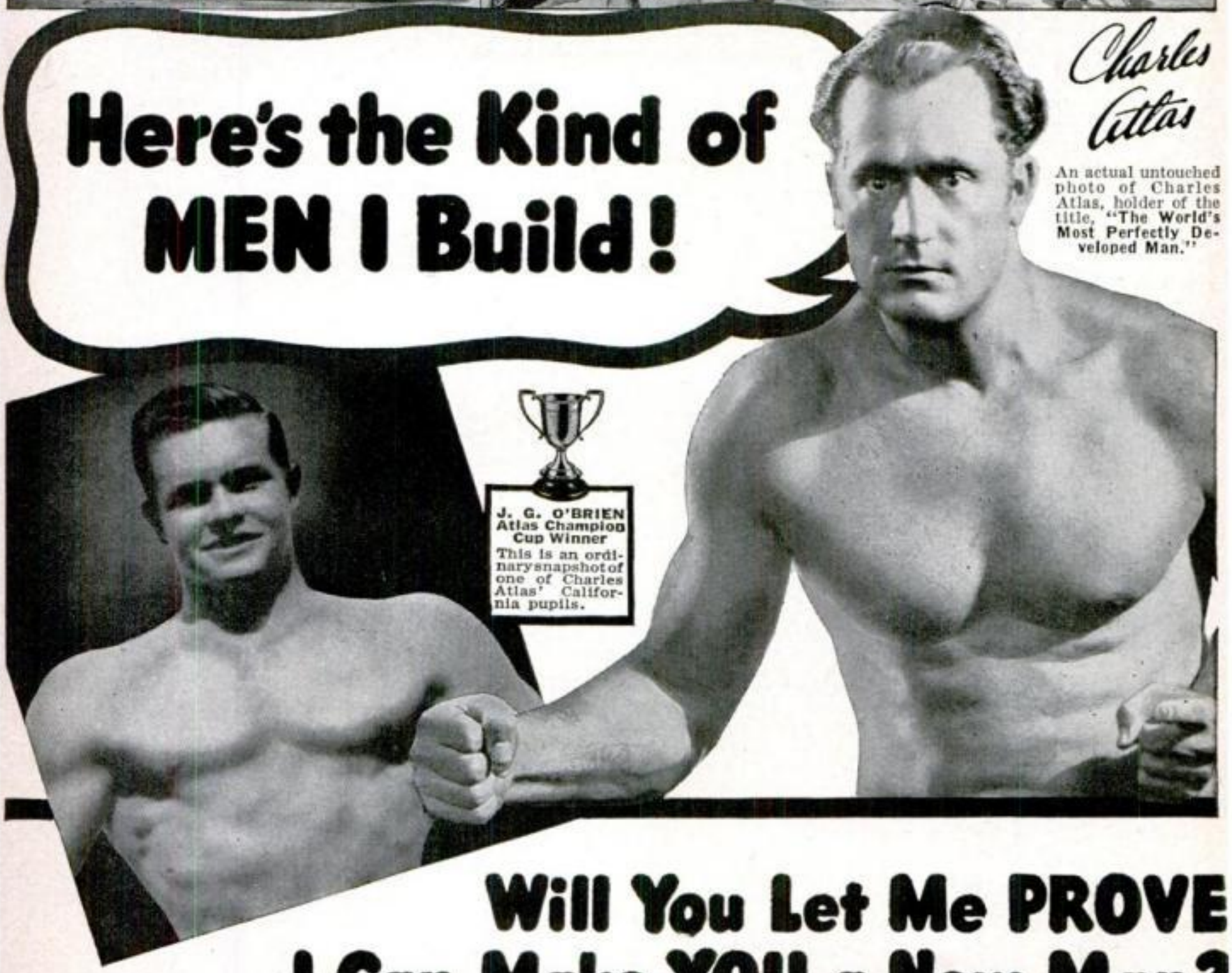

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I DON'T care how old or young you are, or how ashamed of your present physical condition you may be. If you can simply raise your arm and flex it I can add SOLID MUSCLE to your biceps—yes, on each arm—in double-quick time! Only 15 minutes a day—right in your own home—is all the time I ask of you! And there's no cost if I fail.

I can broaden your shoulders, strengthen your back, develop your whole muscular system INSIDE and OUTSIDE! I can add inches to your chest, give you a vise-like grip, make those legs of yours lithe and powerful. I can shoot new strength into your old backbone, exercise those inner organs, help you cram your body so full of pep, vigor and red-blooded vitality that you won't feel there's even "standing room" left for weakness and that lazy feeling! Before I get through with you I'll have your whole frame "measured" to a nice, new, beautiful suit of muscle!

What's My Secret?

"Dynamic Tension!" That's the ticket! The *identical natural* method that I myself developed to change my body from the scrawny, skinny-chested weakling I was at 17 to my present super-man physique! Thousands of other fellows are becoming marvelous physical specimens—*my way*. I give you *no gadgets or contraptions to fool with*. When you have learned to develop your strength through *"Dynamic Tension"* you can laugh at *artificial* muscle-makers. You simply utilize the DORMANT muscle-power in your own God-given body—watch it increase and multiply double-quick into real, solid LIVE MUSCLE.

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Readers Say:

A Vivid Imagination Gets a New Twist on Propellers

I AM sixteen years of age and have quite an imagination. In your "Readers Say" I have read many wild, but good, ideas which, with a few changes, could be made practical and useful to Uncle Sam. I wouldn't be surprised if some day I should see a plane with my idea on it. At any rate, I would like to make a stab at it. I think it should be possible, since the pitch of a propeller is adjustable, to reverse the pitch of the blades completely and thus have the propeller act as brake against the forward motion of the plane. This would be especially useful in landing fast planes on carriers. The pilot, as he approached the landing deck, could reverse the blade pitch and gun his motor. I see no reason why the plane would not slow down and be almost completely stopped. I suppose some engineers will slap me down with a lot of technical objections, but still I wouldn't be too surprised if my idea worked. I think it is a practical answer to getting fast planes on carriers. Just think what it would mean to get some P-40's or Thunderbolts on carriers to slap the Japs. Yours in imagination.—W. Y., Hayden, Ariz.

Has the Answer to a Puzzler, But Now Wants a Spectroscope Model

HERE is something I would like you to print in "Readers Say." A man has $100 with which he has to buy 100 dresses—no more or no less. In these 100 dresses he has to include 50-cent dresses, three-dollar dresses, and ten-dollar dresses. How many dresses of each kind does the man have to buy? Remember that he has to spend the entire $100—and no more. How about some of your puzzle fans and math wizards trying that one? It took me three and one half minutes. Just keep up the good work. How about a model of a spectroscope? I've been trying to get plans for it elsewhere, but with no success. So I might as well try P. S. M. I'm sure to get it there (I hope!)—J. L., New York, N. Y.

We're happy to be able to tell you, J. L., that your hope has come true on page HW 508 of this issue.—Ed.

We Were Just Too Modest About That Midget Radio

I HAVE been a subscriber to P. S. M., for two years and have found it to be very helpful. It is difficult to praise your radio department too highly. It's the best of its type I know of today. The midget radio described in your August 1941 issue is great. A 400-mile range is not enough to say about the little set. I can receive stations twice that distance with good volume.—O. C., Dover, Tenn.

This Inventor Is Flying High on Thin Air

I HAVE a problem that's bothering me a little. A balloon filled with hydrogen gas will rise, we'll say, to about a 14,000-foot level. Helium isn't obtainable, and hydrogen is both imflammable and explosive. It is dangerous to use. O. K. Now up on Pikes Peak, at an altitude of 14,000 feet, the air is so light and thin that many have trouble even breathing it. Why not take balloons up there and inflate them with this light air? Or possibly lay a pipe line down the side of the mountain and draw the light air down to fill blimps and balloons? Wouldn't that balloon sort of be at home in the 14,000-foot level? And it wouldn't be inflammable. There are very few "no smoking" signs in the rarefied regions. Oh well, maybe the whole idea is nothing more than "Arizona hot air" at that. There are millions in the idea, and I still think it is a good one—even if it won't work.—A. H. W., Phoenix, Ariz.

More Power to His Binoculars! Can You Help Him?

I WOULD like to see this in P.S.M.'s, "Readers Say" department. I have an eight-power pair of binoculars which I would like to increase to ten power or more, if possible. The binoculars are 8 x 30 Stereo-Kinux, Paris. I would like to see an answer to this one from one of your readers.—J.R., Shenandoah, Pa.

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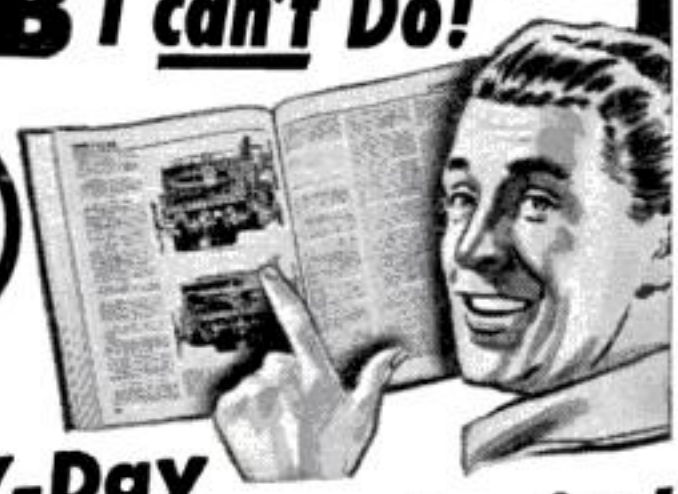

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Readers Say:

A Cipher Exponent Comes Up With an Explanation

I AM taking the liberty of sending you the following information which I think might explain even more clearly the operation of the Fleissner grille mentioned in your November article on secret codes. To make perforations for a grille so that when the square is turned into its four possible positions all the cells will be filled, choose a square of any size desired—say eight cells to a side—which can be divided into four quarters. Mark the upper left-hand corner of the first square and number the squares. Consider this quarter turned clockwise on the second quarter and number the cells, and so on to the fourth quarter. Now we may perforate any numbers we wish in the first quarter, but must not perforate the same numbers in any other. And so with the second, third, and fourth. Needless to say, there must be 16 perforations in all. The example above shows a selection that will answer, although different selections may be made.—A. L. S., Mildred, Pa.

Another Home Chemist Wants to Experiment on The Japs

I HAVE read your magazine for a great many years, and I agree with E. J. S., of Davenport, Iowa, that there are many home chemists who would like to help win the war. I own $100 worth of chemicals. Personally I would be willing to do anything at all if it would help old Uncle Sam whip those rice-eating rodents.—S. L., Nanty-Glo, Pa.

We'll Spot Those Wolves Even in Our Ships' Clothing

SOMEONE recently asked in "Readers Say" if it would be possible for enemy planes to have American insignia put on them and thus invade the U. S. The answer is no—because New York Spotters would recognize the planes not by their insignia, but by their outlines.—F. C. S. Jr., Cincinnati, Ohio.

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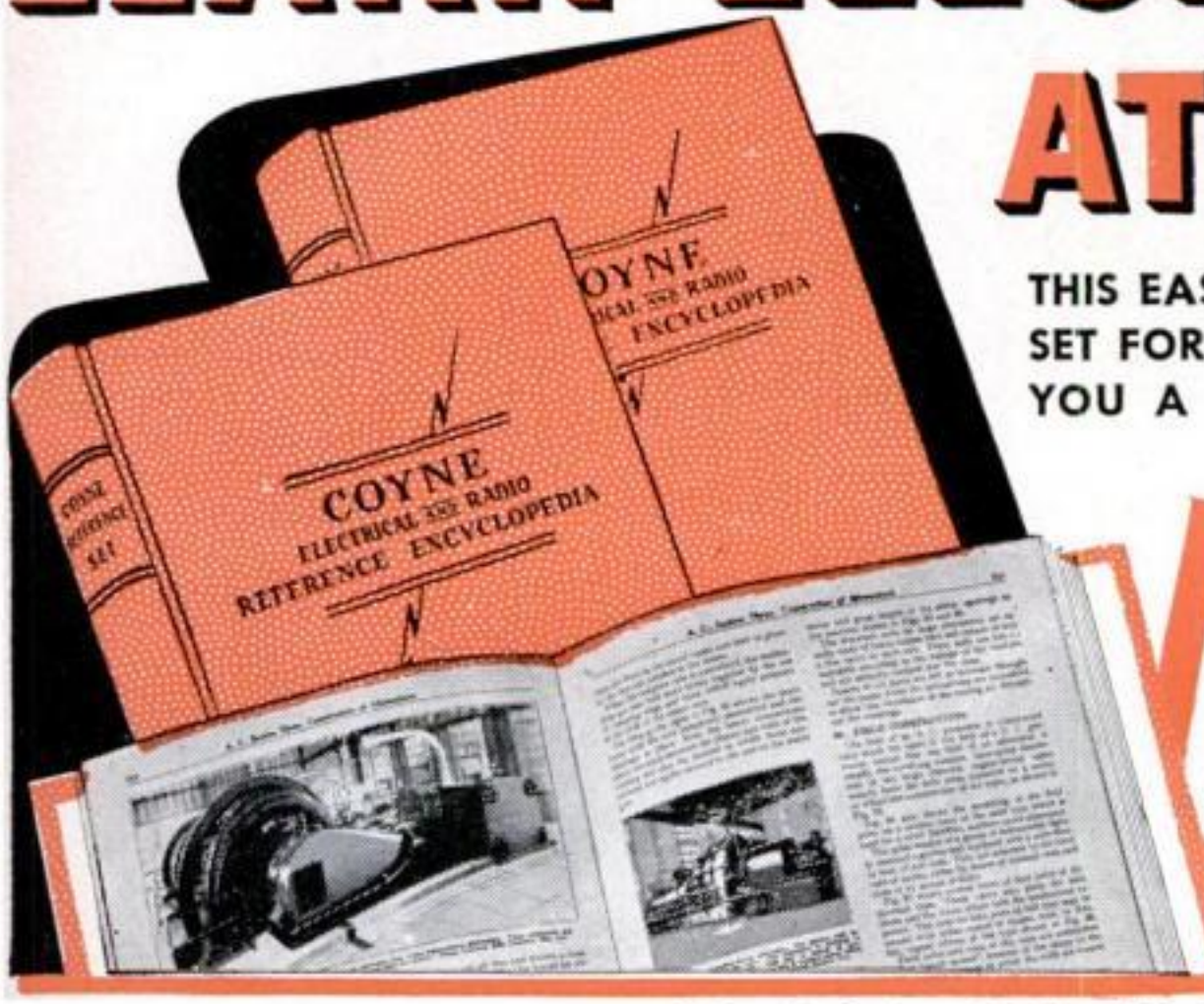

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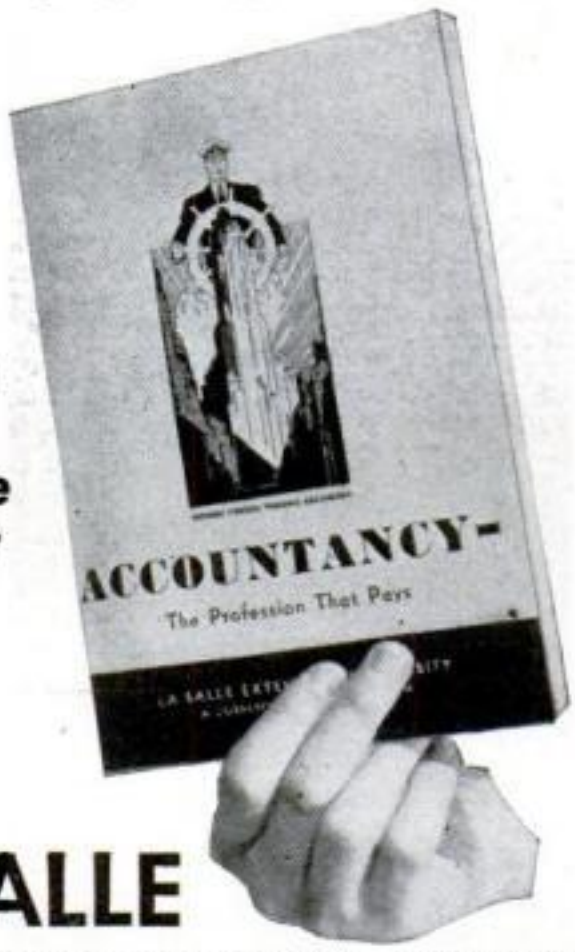

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Readers Say:

Wanted: an Answer to This Bounding-Ball Baffler

I HAVE an item which I believe will be of interest to some of the more ardent math fans who read your column every month. I would like to see a correct solution to this problem—if there is a really good one that can be proved. Here it is;—A ball is dropped from a window 16 feet above the ground. It rebounds eight feet. It drops again and rebounds four feet. It continues to drop and rebound each time one half as far as it did the preceding time. How far will the ball have traveled when it finally comes to rest? I am at loss as to the solution for, as someone's theory states, zero is approachable by continuous dividing of a number—but zero can never be reached. I would appreciate it if someone would clear up the matter for me.—R. P. S., Bakersfield, Cal.

He Hoards History in Headlines

THE ITEM in "Readers Say" signed by C. B. of Denver, Colorado, who collects front pages of his local newspapers, attracted my attention to the extent of writing this letter. I also have a hobby of saving newspapers with important headlines. I have a collection of some 300 with such headlines as McKinley's assassination; the deaths of Harding, Coolidge, Wilson, Bryan, the Kaiser, King George V, Wiley Post, and Will Rogers; the Titanic and Lusitania disasters; the elections of Presidents Teddy Roosevelt, Wilson, Harding, Hoover, Coolidge, and F. D. Roosevelt; the birth of the Dionne quintuplets; Lindbergh's flight to Paris; the armistice of November 11, 1918; Pittsburgh's great flood of 1936; the start of the Russo-Japanese War in 1904; the San Francisco earthquake in 1906; Tunney's victory over Dempsey; Gertrude Ederle's swim across the English Channel; King Edward's ascension to the throne, and his abdication; the crowning of King George VI; the Hindenburg, Macon, Akron dirigible disasters; the 31,400-foot parachute jump by Arthur Starnes, and others.—C. W. B., Pittsburgh, Pa.

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I Am Ready to HELP YOU Help WIN THE WAR

J. Edgar Hoover Director

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You're a good loyal American; you want to do your part! All of us can't be soldiers, or sailors, or air pilots, but we can serve. One way to do it is to master a trade or vocation which will help win the war and at the same time prepare you for a good position after the war is over.

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Training which enables you to thwart crime within our own borders will help to win the war with the Japs and other foreign foes. You'll get such training through the I.A.S. Course in Finger Printing and other Crime Detection Methods, and you can *learn right at home,* in spare time, at small cost.

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From the News Editor's Desk

ENGLAND'S TRADITION of always being able to "muddle through" her difficulties is again indicated by the news that she has found a substitute source for vitamin A. Prior to the war, she found it in the usual places—tomatoes, oranges, and other fruits. Now her scientists have discovered it in pickled walnuts, one of which will give a person twice the amount needed for one day. An interesting footnote to the discovery is that a Mrs. Hannah Glasse published a palatable recipe for pickling unripe nuts as far back as the eighteenth century.

THE TESTING OF GAS MASKS has now been made both foolproof and speedy by the use of fluorescent chemicals. Finely powdered anthracene is allowed to seep into a test chamber flooded with ultraviolet light which gives the powder a bright green glow, and renders its penetration through any part of the mask easily detectable. Liquids and vapors can be used in the same manner, depending on whether the mask is intended to protect the wearer against gas, smoke, or fog. Even a chemical as diluted as one part in several hundred million can be readily seen on a wearer's face inside the mask by means of "black light."

A SUCCESSFUL VACCINE for protection against infantile paralysis appears to have been discovered in a research reported by Dr. E. Racker, of the Harlem Hospital of New York, who believes he has found the pure virus in crystals of a chemical which are protein in nature. Purification of a virus is the first step in finding ways to fight a disease, for it allows the scientist a greater latitude of experimental methods and provides him with findings that can be accepted with greater assurance. In the case of infantile paralysis, the new virus will permit experiments on animals cheaper than monkeys—heretofore the only suitable subjects.

DEHYDRATED FOODS, now being supplied to our fighting men by the hundreds of millions of pounds, are not the newly created products that many might suppose. As far back as the Spanish American War, the American Navy was supplied with dehydrated potatoes—the only trouble being that they tasted like anything but potatoes and had the color of a fairly new brown derby. Dehydration has come a long way since then, for besides an increased variety of foods which can be dried out, the food itself is the equal of fresh foods in texture, flavor and nutrition.

THAT PINK-FLESHED TROUT, and presumably other fish too, contain more vitamin A than their pale-faced brothers should come as good news to those vitamin-conscious consumers who are seeking to maintain a diet that is healthy as well as thrifty. In line with this discovery, there is under consideration the idea of feeding vitamin A foods to pond-raised trout—the thought being that not only will the pond owners produce more attractive, and therefore more saleable, fish, but that the consumers too will benefit from the increased nourishment.

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HOW TO GET INTO AVIATION—NOW

by C. S. (Casey) Jones

NO. 2 *in a series of advertisements describing the free training and opportunities now available in aviation. Addressed to the thousands of men and women who wish to prepare themselves for war service in this key industry.*

C. S. JONES

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(D) *Supplementary Courses*—for employed persons in war industries to train for better jobs. 6 to 10 hours per week.

(E) *Conversion Courses*—for employed persons who wish to get into war industry. 15 hours of training per week.

Courses in *aircraft maintenance* include Aircraft Engines, Aviation Mechanics, Aircraft Instruments. Courses in the *building of aircraft* include: Sheet Metal Work, Riveting and Assembling, Final Airframe Assembly, Mock-up, Layout and Inspection.

Many or most of the courses are open to both men and women. Any person of 18 years up, who is trainable and employable, may enroll. For further information, apply to your nearest vocational school, high school or local office of U. S. Employment Service.

C. S. Jones
President

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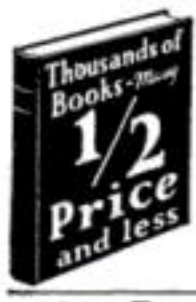

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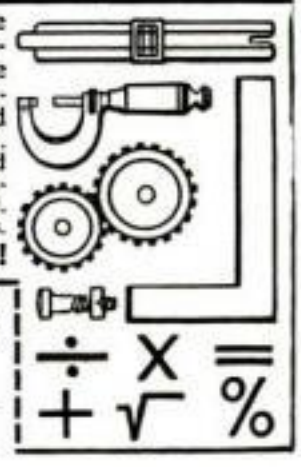

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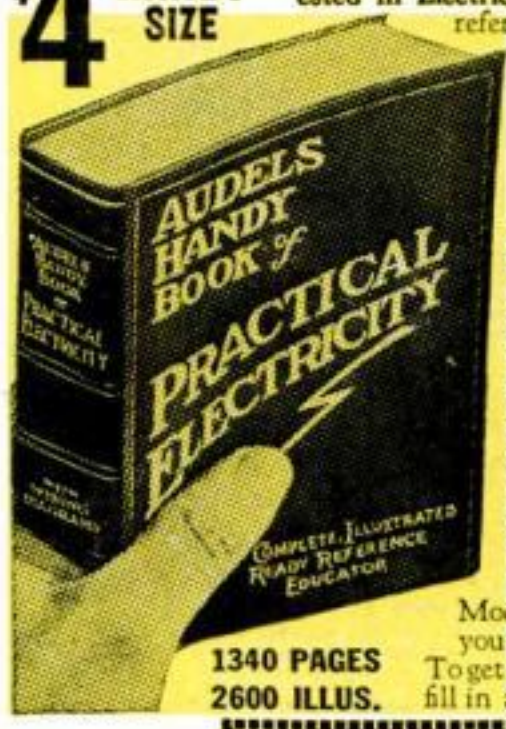

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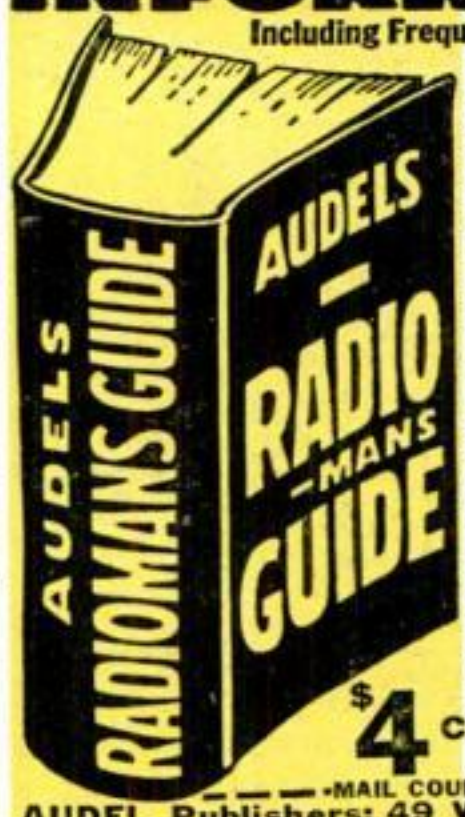

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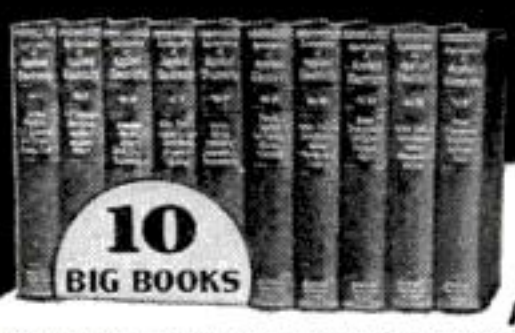

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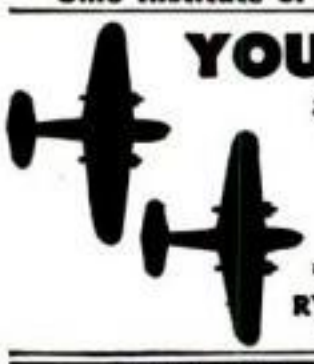

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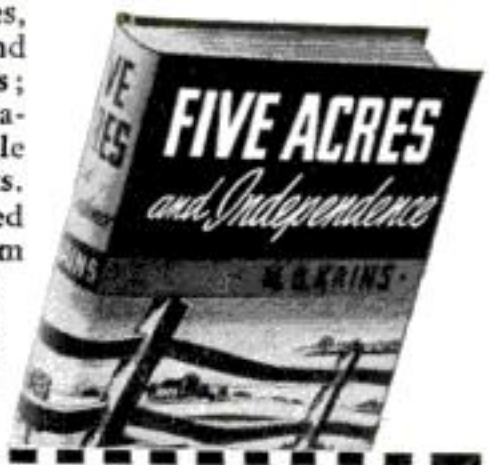

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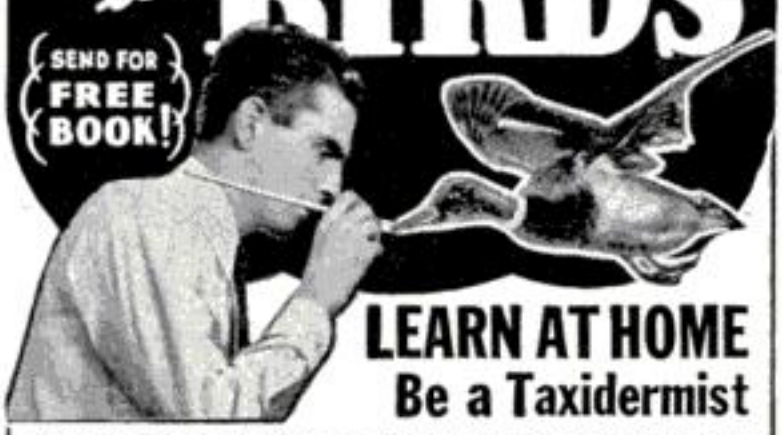

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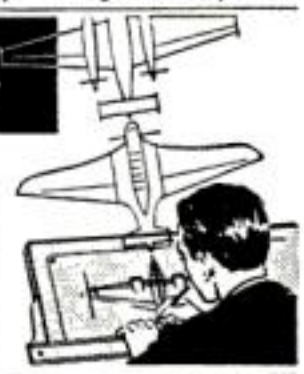

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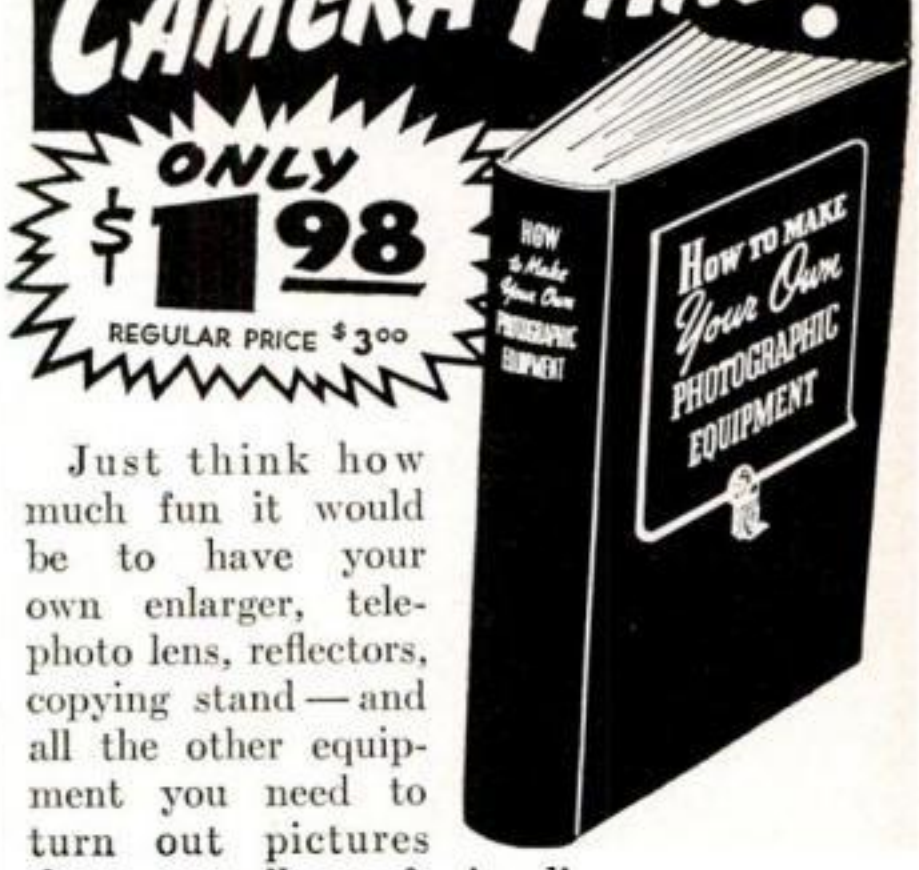

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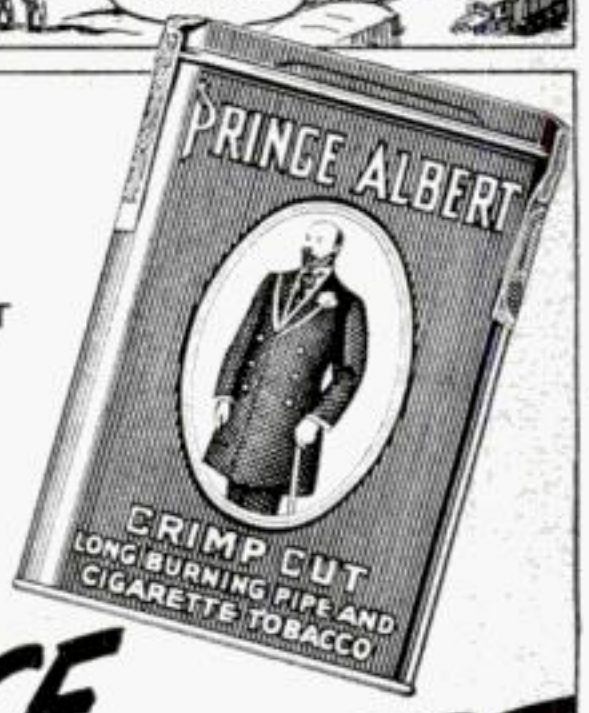

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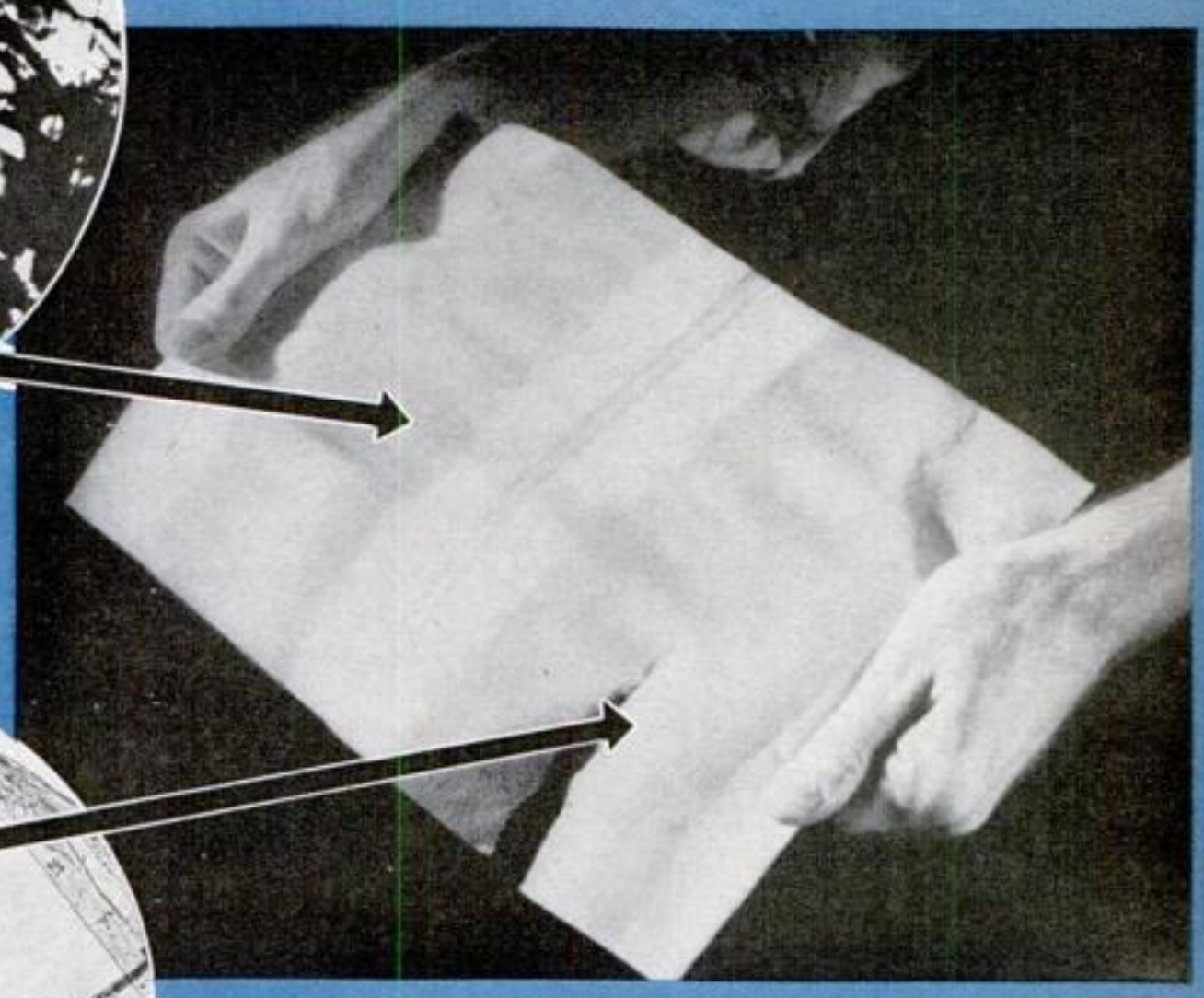
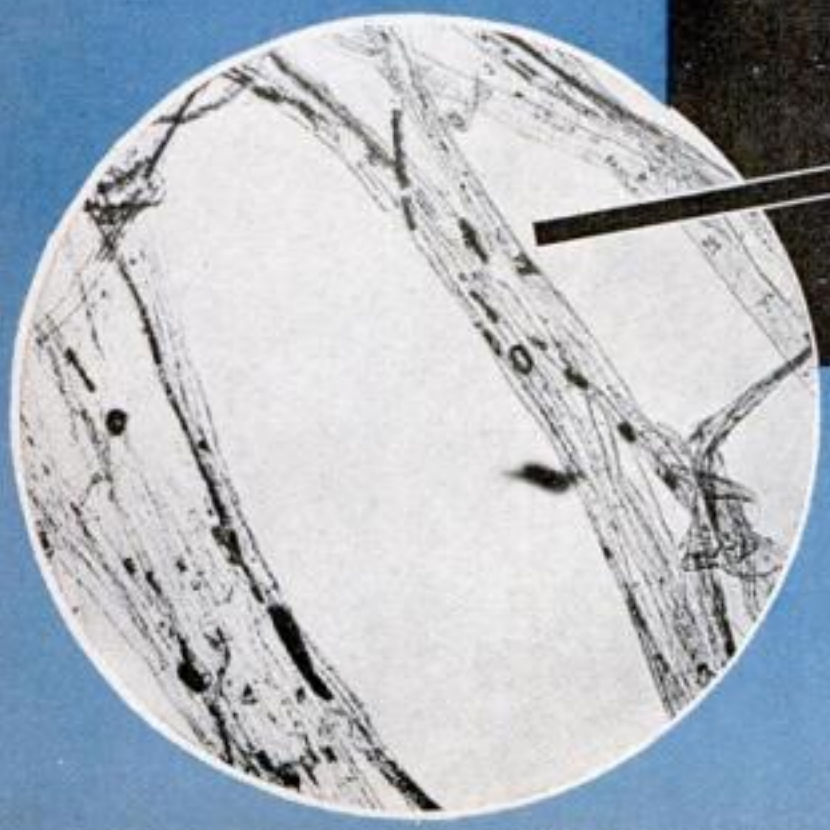
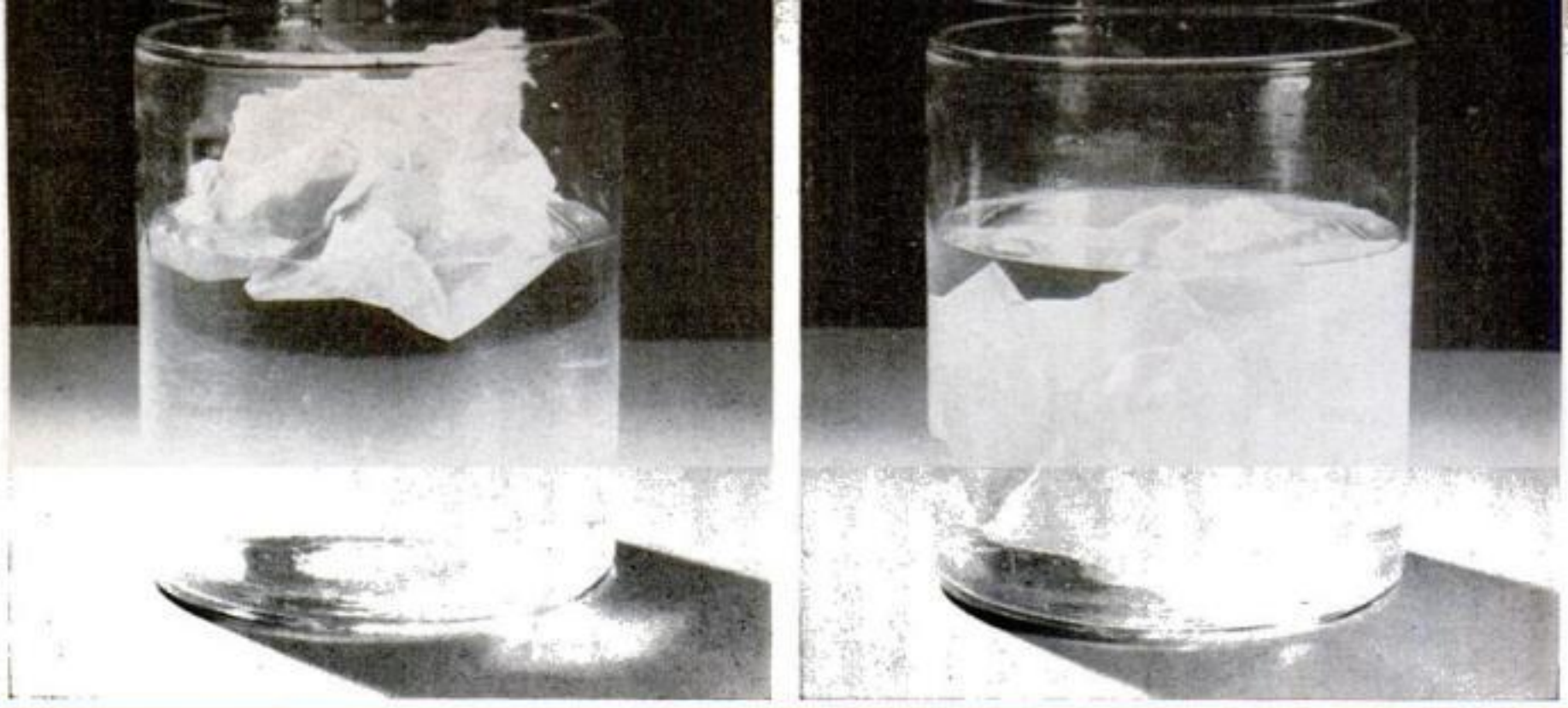
AQUALIZED PAPER. Photomicrograph reveals its fibers wet and under strain. Fibers are so firmly welded that water does not loosen them nor cause disintegration as in ordinary paper





UNPROCESSED PAPER. Soaked and under stress, its fibers appear as at left. As a test, the two papers are fastened together and the center of each is soaked with water. Ordinary paper parts quickly under strain; Aqualized remains whole



PROPERTIES: The capacity of Aqualized paper to absorb water is in no way reduced by its unusually cohesive texture. Placed in a jar, as at right above, it will submerge quickly and completely, while ordinary paper, having little absorbency, will remain afloat. Engineers are investigating the possible use of waterproofed Aqualized paper in place of war materials

paper may soon have to be recruited to fill innumerable gaps created by wartime scarcities. In Germany it is already being used for clothing, pup tents, sandbags, and camouflage. Aqualized paper, with its high wet strength, is now being impregnated, coated, or otherwise processed, in an effort to adapt it to these and other emergency applications.

Developed in the research laboratories of the Brown Company—paper manufacturers and large producers of pure cellulose—in New Hampshire, the Aqualizing process is different from any other water-resistant treatment. It is not a process of waterproofing, in the common sense, but rather one of so changing the actual paper fibers that water cannot weaken them. Waterproof paper is water-*resistant* only so long as the surfacing material is unbroken; crack this surface and the water attacks the fibers as it would those of ordinary paper. Aqualized paper, on the other hand, resists the weakening effect of water regardless of whether the paper has been surface-processed or left absorbent; whether the surface is cracked or whole.

Ordinary paper is weak, when wet, because water starts the whole paper-making process in reverse. In the manufacture of paper, the individual fibers of cellulose are separated by the use of large quantities of

USES: Ideal use for this new paper is as a potato bag or vegetable-crate lining. Because of its resistance to vegetable moisture, contents will not break through as in ordinary bags

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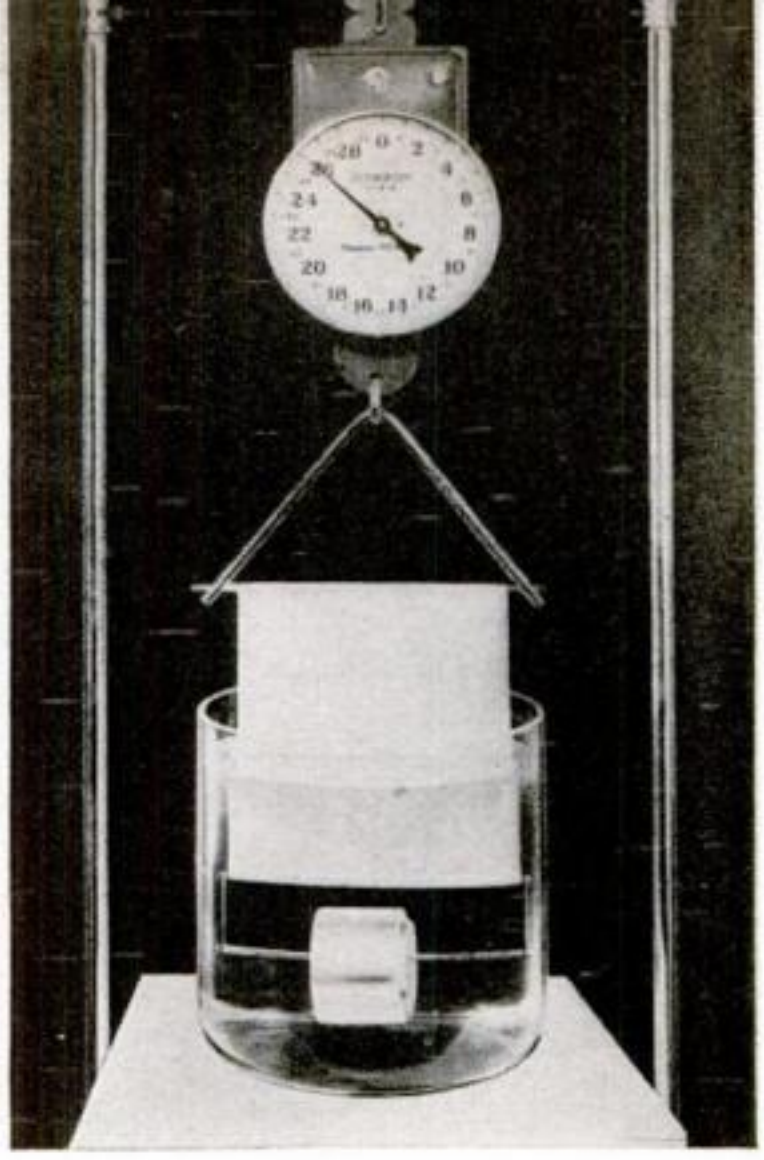


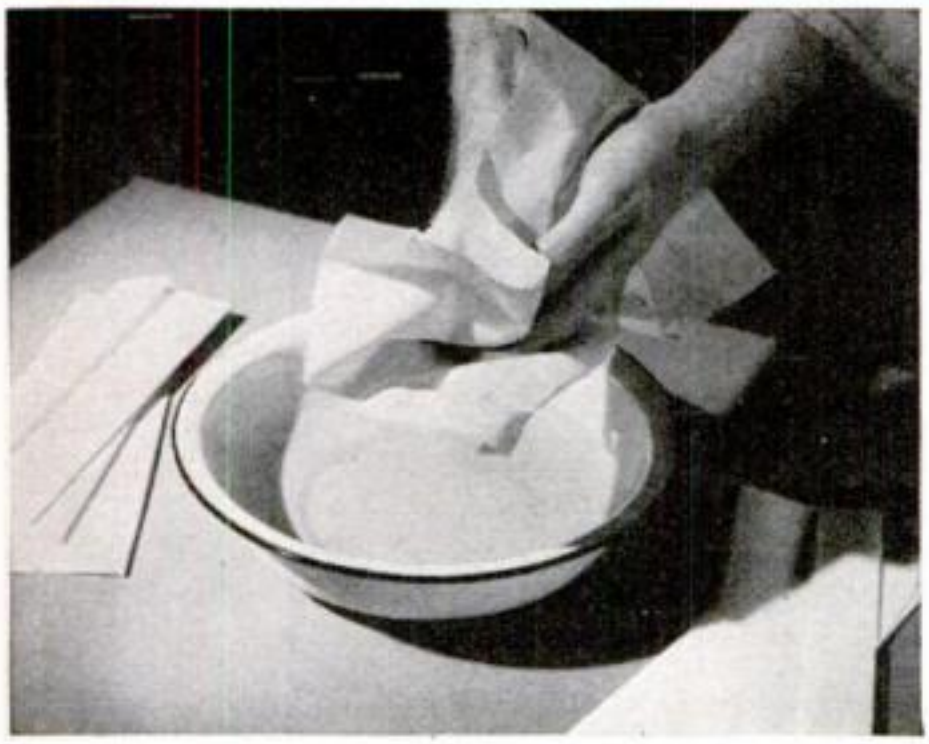
Although firmly fibered, Aqualized paper is comparatively porous, as indicated by the experiment above, showing water dropping through the paper to the bowl below. Even after long immersion, however, the paper will support 26 pounds

water in the beater. These fibers are first formed on a wire screen which shakes them evenly into position, and are then dried under heat and pressure until they take the form of a sheet of paper.

When such paper comes once more in contact with water, the process begins to work backward. The water penetrates the fibers, swells them, and finally floats them apart as separate entities, as they were before they were converted into paper. Such water-soaked paper naturally weakens and then disintegrates completely.

In the Aqualizing process the individual fibers are treated with a secret chemical binding compound which is scientificially distributed throughout the fibers. This compound causes a fusing of the fibers, where they touch each other, making it impossible for water to get between them to pry them apart. As a result, the wet strength of the paper goes all the way through. Such paper may absorb as much water as ordinary paper, the only difference being that the Aqualized paper remains strong. In fact, Aqualized paper is usually more absorbent than other types of paper, which is why it is put to such good use as a paper towel. It may also be coated with wax and resin to waterproof it, but the sheet will retain its strength even if this coating should be broken or cracked by rough usage.

Superiority of Aqualized over unprocessed paper is seen immediately when each is used as a towel. Under rough handling the ordinary paper tears easily, while the other, although soaked, remains firm



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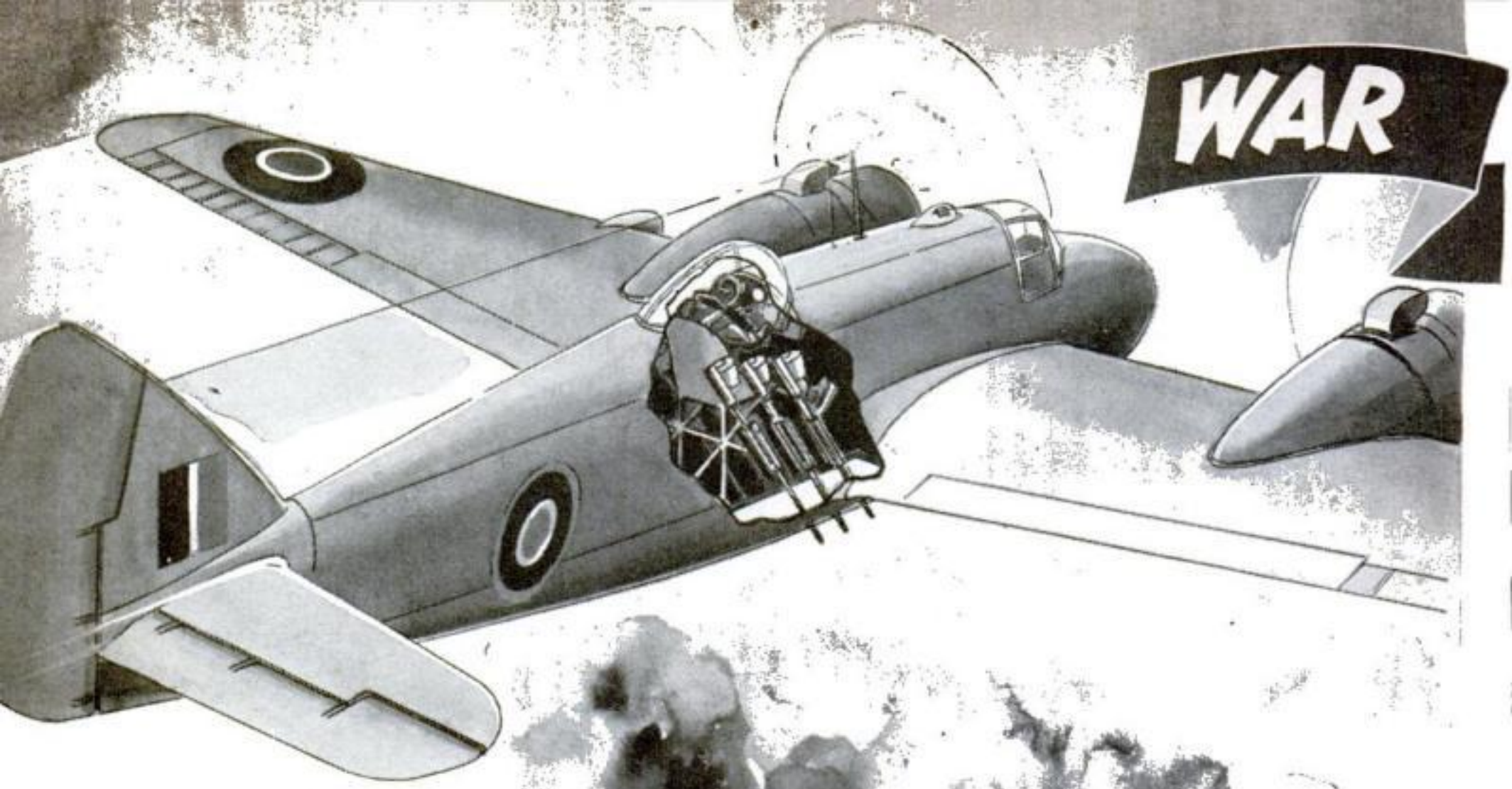
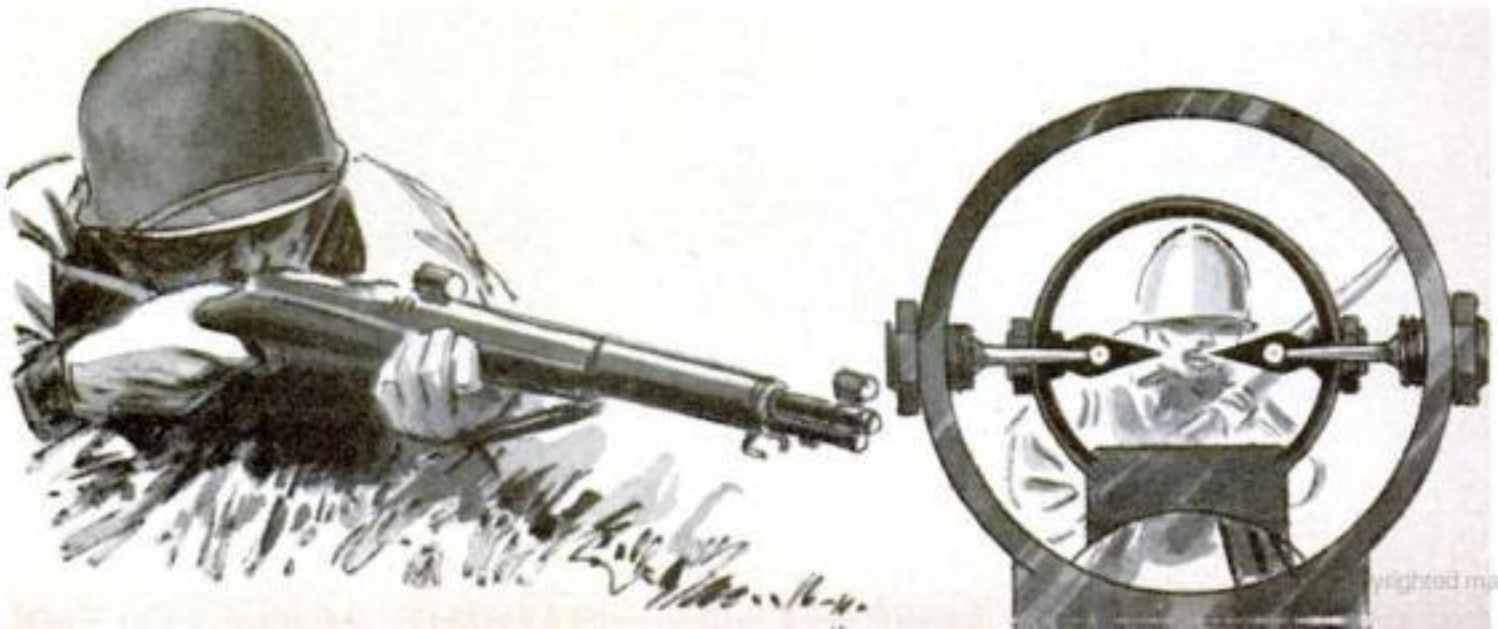


PLANE TANK-BUSTER CANNON are proposed for such planes as the British Bristol Beaufighter, which is seeing much service in the Middle East where Rommel's tanks are active. A battery of antitank cannon would be installed in present planes, as pictured above, pointing downward so that the plane could fly on an even keel and rake a tank with heavy fire from end to end. Other guns, of course, would be retained, and the plane, despite its highly increased fire power, would continue to serve its primary purpose as a fighter.

PARACHUTE JACKETS, replacing the conventional seat and chest packs, are advocated as less bulky, more comfortable for the wearer, and as a means of contributing extra warmth through a revised method of folding. The jackets are sleeveless, reach to the thighs, and have a built-in harness. They should be of special value in large aircraft where crews move about.

IMPROVED VISION IN SIGHTING FIREARMS is the object of an invention employing horizontal pins in front and rear sights. With these projections aligned, as shown, a bead is held on the target, which is visible between, above, and below the pins.



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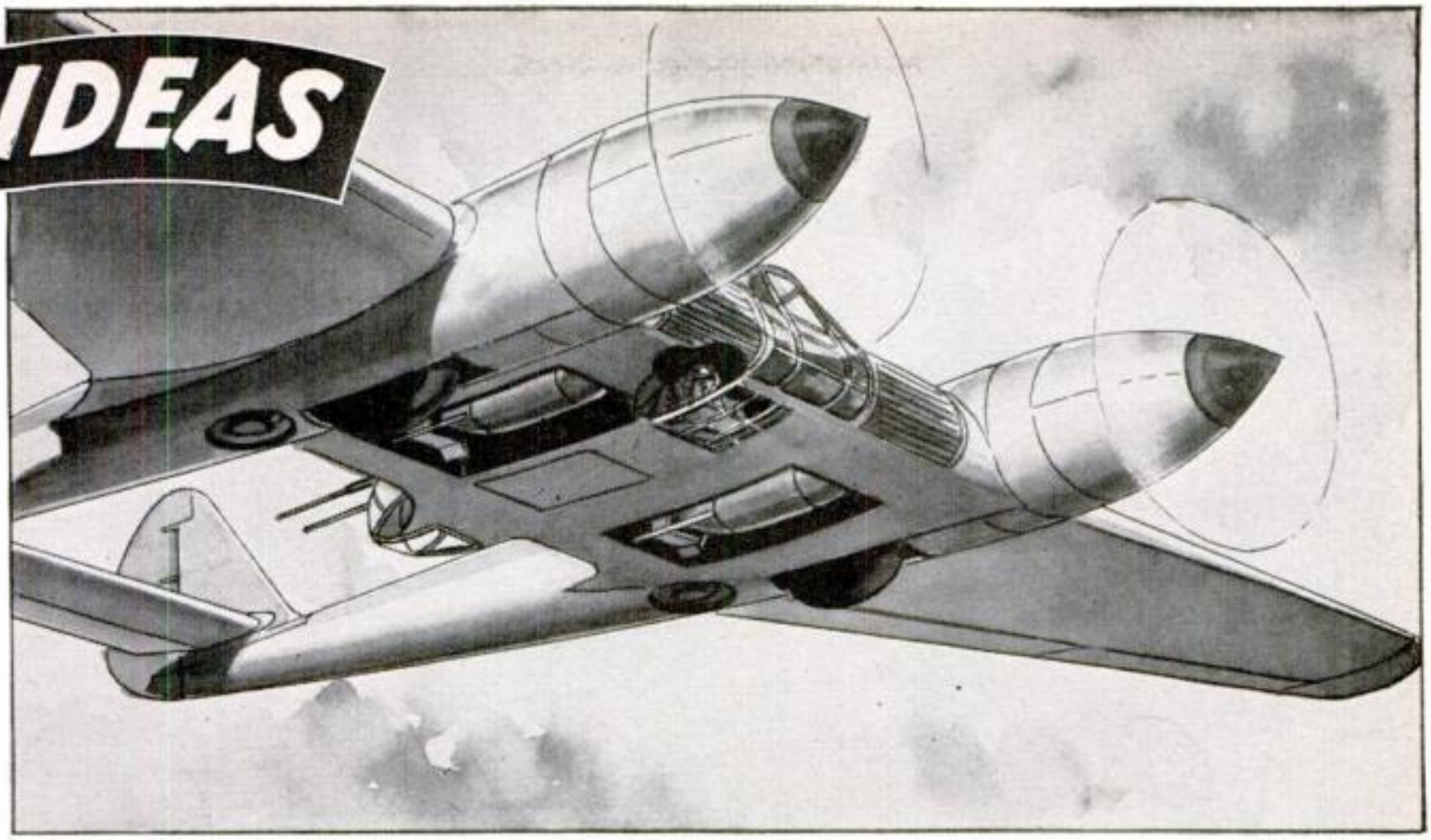
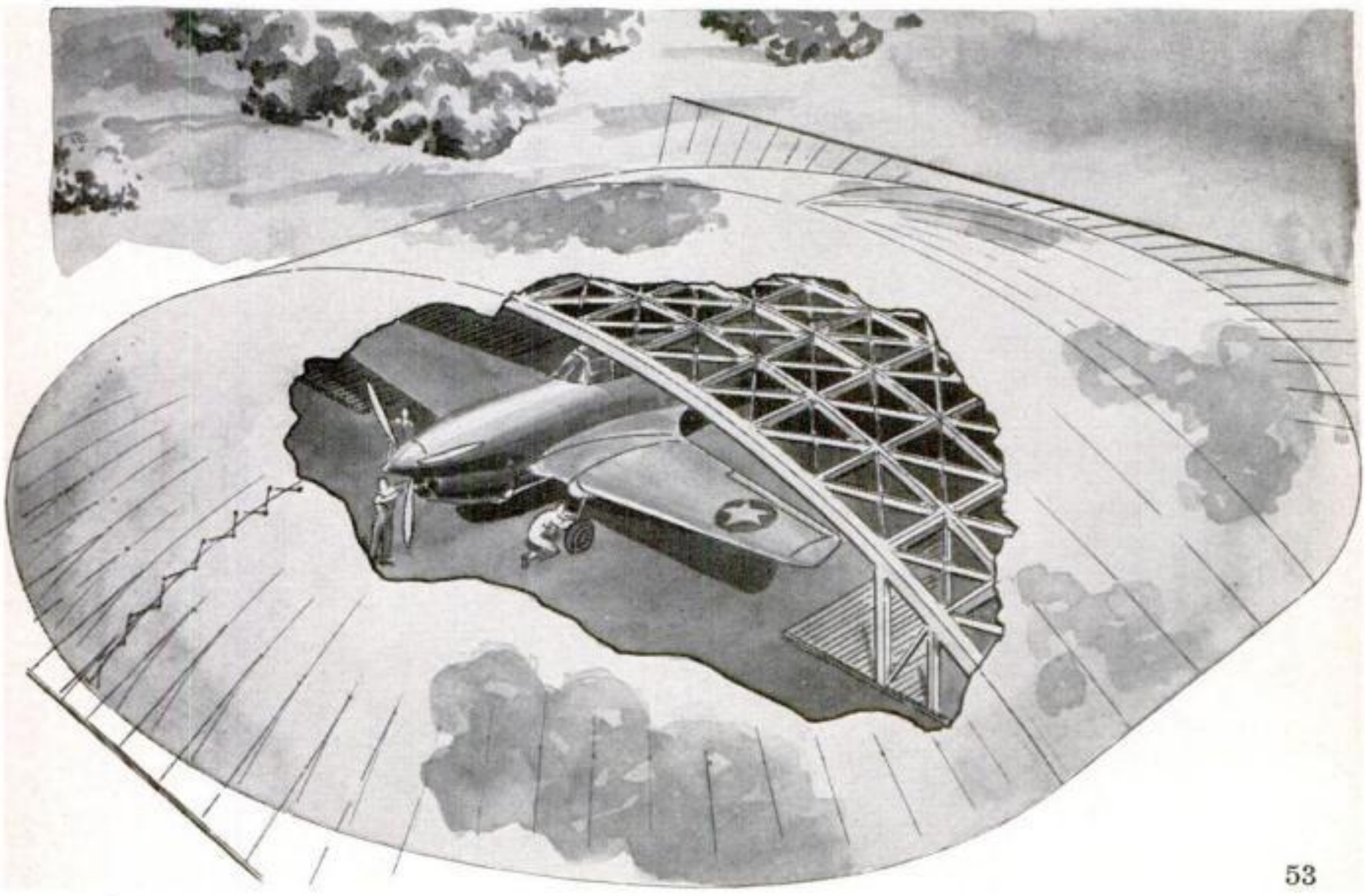
IDEAS



TWO BOMB COMPARTMENTS are provided in a newly designed all-wing plane with quarters for pilot and crew in the central wing section, which is of airfoil contour and contributes to lift as well as housing the load. This central portion has a maximum height of 5½ feet which is reduced to 3½ feet on either side of that part used by the crew. In addition to its bombing devices, the plane carries both forward and rear guns—the latter being capable of full vertical range.

QUICKLY SET UP SINGLE-PLANE HANGARS, easily camouflaged with their turtle-back design eliminating shadows, have been patented here and in England. The arched-rib framework—steel for large hangars or trussed wood for small ones—is roomy enough to accommodate personnel. Its canvas covering can be drawn back for openings at both ends. By use of roofs and partitions, the shelters could easily be adapted to temporary housing for another purpose.



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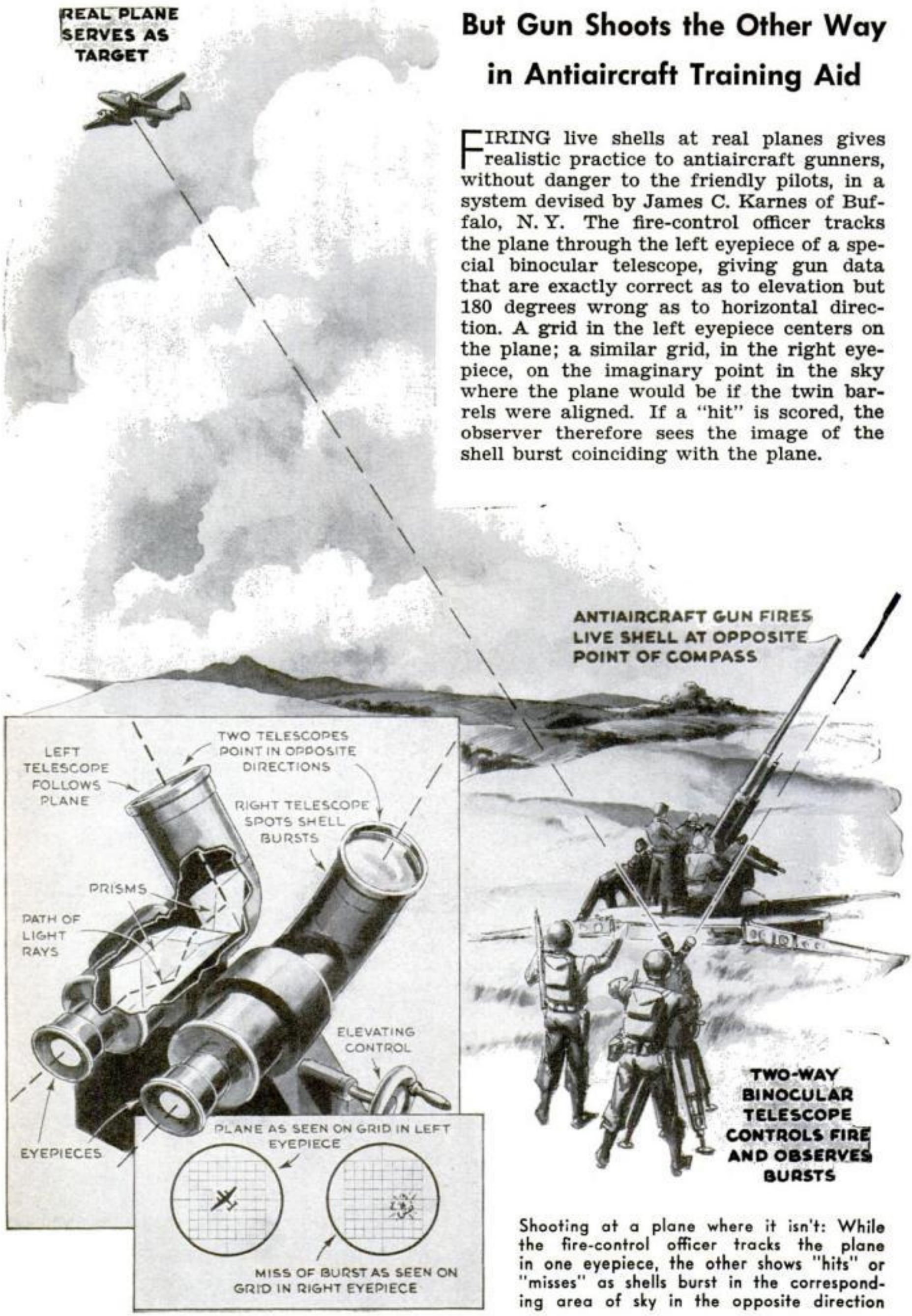
Gunners Sight on Real Planes, But Gun Shoots the Other Way in Antiaircraft Training Aid

FIRING live shells at real planes gives realistic practice to antiaircraft gunners, without danger to the friendly pilots, in a system devised by James C. Karnes of Buffalo, N. Y. The fire-control officer tracks the plane through the left eyepiece of a special binocular telescope, giving gun data that are exactly correct as to elevation but 180 degrees wrong as to horizontal direction. A grid in the left eyepiece centers on the plane; a similar grid, in the right eyepiece, on the imaginary point in the sky where the plane would be if the twin barrels were aligned. If a "hit" is scored, the observer therefore sees the image of the shell burst coinciding with the plane.



Shooting at a plane where it isn't: While the fire-control officer tracks the plane in one eyepiece, the other shows "hits" or "misses" as shells burst in the corresponding area of sky in the opposite direction

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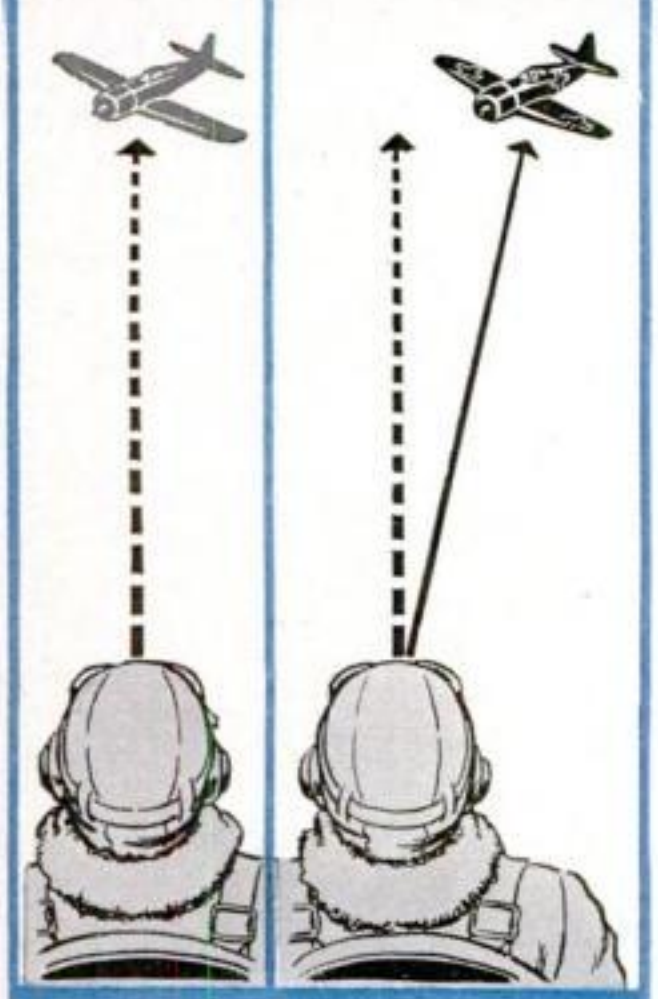

The trick in sighting a faint object at night is not to look at it directly, as at left, but to view it out one corner of the eye

Eyes That See in The Dark

"DARK ADAPTATION" SOLVES QUICK ADJUSTMENT TO NIGHT VISION

DO YOU know how to see in the dark? New scientific tricks enable you to do it better, and more swiftly. If you step from the street into a dark movie theater, it will take several minutes to see your way around, and half an hour before your eyes' "dark adaptation" is complete. But warplane pilots, lookouts at sea, and air-raid wardens can't wait that long. Now military experts offer ways to prepare a person's vision in advance of night duty without the inconvenience of sitting in total darkness.

Simplest of all, wear over one eye, for thirty minutes, a standard black eye patch from any medical counter—

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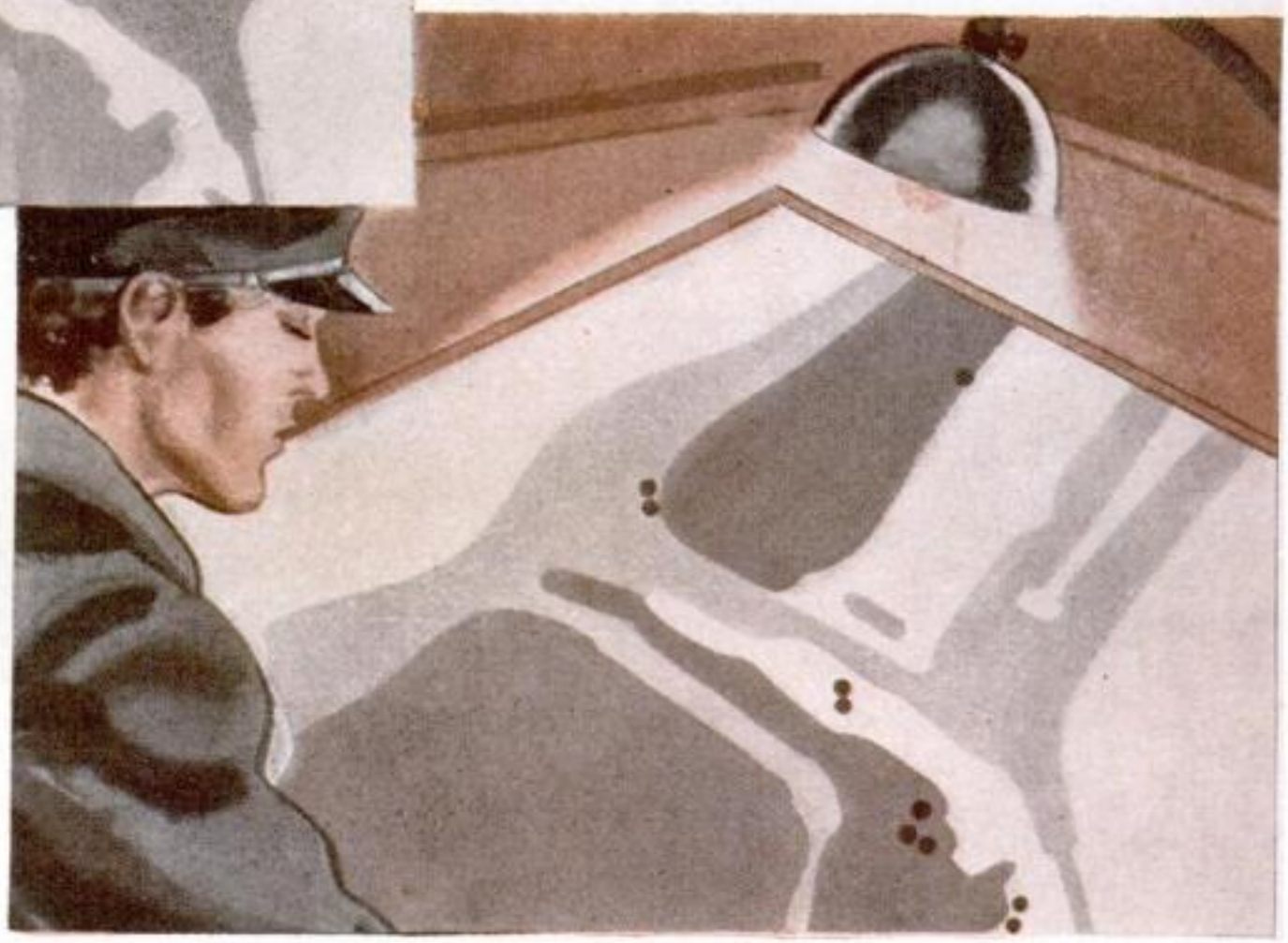
The new official Navy charts, designed by the United States Hydrographic Office, have been done in colors which clearly distinguish vital areas one from another even when viewed under a red bulb or through red-lensed glasses

FEATURES	UNDER DAYLIGHT	UNDER RED LIGHT
Land	Gray	Light-gray
Lights	Purple	Purple
Deep water	White	White
Shallow water	Light-blue	Medium-gray
Shoals	Dark-blue	Dark-gray



The original Navy charts, above, done in colors to indicate such strategic areas as shallow water, deep water, land, shoals, lights, etc., were found to be entirely satisfactory until the coming of the dark-adaptation method. It was then found that the tinted sections, when seen under a red light, became either white or gray, thereby losing all value of distinction. This obstacle was overcome by using a new set of colors, outlined in the list, which makes a map's colored sections equally vivid under red or white light (right)

THREE METHODS BY WHICH FLYERS'

DARK-ADAPTATION GOGGLES. Used to adjust flyers' vision to night flying, they must fit snugly and be neither too weak nor too strong a shade of red. A weak shade admits too much light; a dark shade, not enough

Wearing a patch over one eye for 30 minutes will prepare that eye to see in the dark. Good for distance vision

making sure that no light leaks in. Step into the darkness, remove the patch, and that eye will be ready to spot a lurking sub in the night. The other eye will come along later. This scheme is recommended only for long-range vision; it takes two good eyes to keep from bumping into near-by objects.

Another plan avoids the hazard. Simply don close-fitting, red-lensed goggles. Their special tint excludes practically all rays used in day vision, allowing both eyes to accustom themselves to the dark at once. Or the room illumination may be of the desired hue, obviating need for goggles, if all the occupants are preparing for night duty.

Even momentary exposure to bright, white light will ruin night vision. Therefore the U. S. Hydrographic Office is altering the color scheme of its official Navy charts so that they may be viewed under red light or through red goggles.

Formerly it printed land areas, lighthouses, and deep water in buff, orange-red, and white, respectively. By red light, all became indistinguishably white, and the lighthouses disappeared! Shallow water and shoals, printed in blue and in green, became a uniform gray.

Through skillful color juggling, the new charts differentiate all features, under daylight and red light, too. With red illumination, land areas, printed in gray, appear light-gray; lighthouses, printed in purple, retain their color; deep water, printed in white, remains white; shallow water, printed light-blue, becomes medium-gray; and shoals, printed dark-blue, turn to dark-gray.

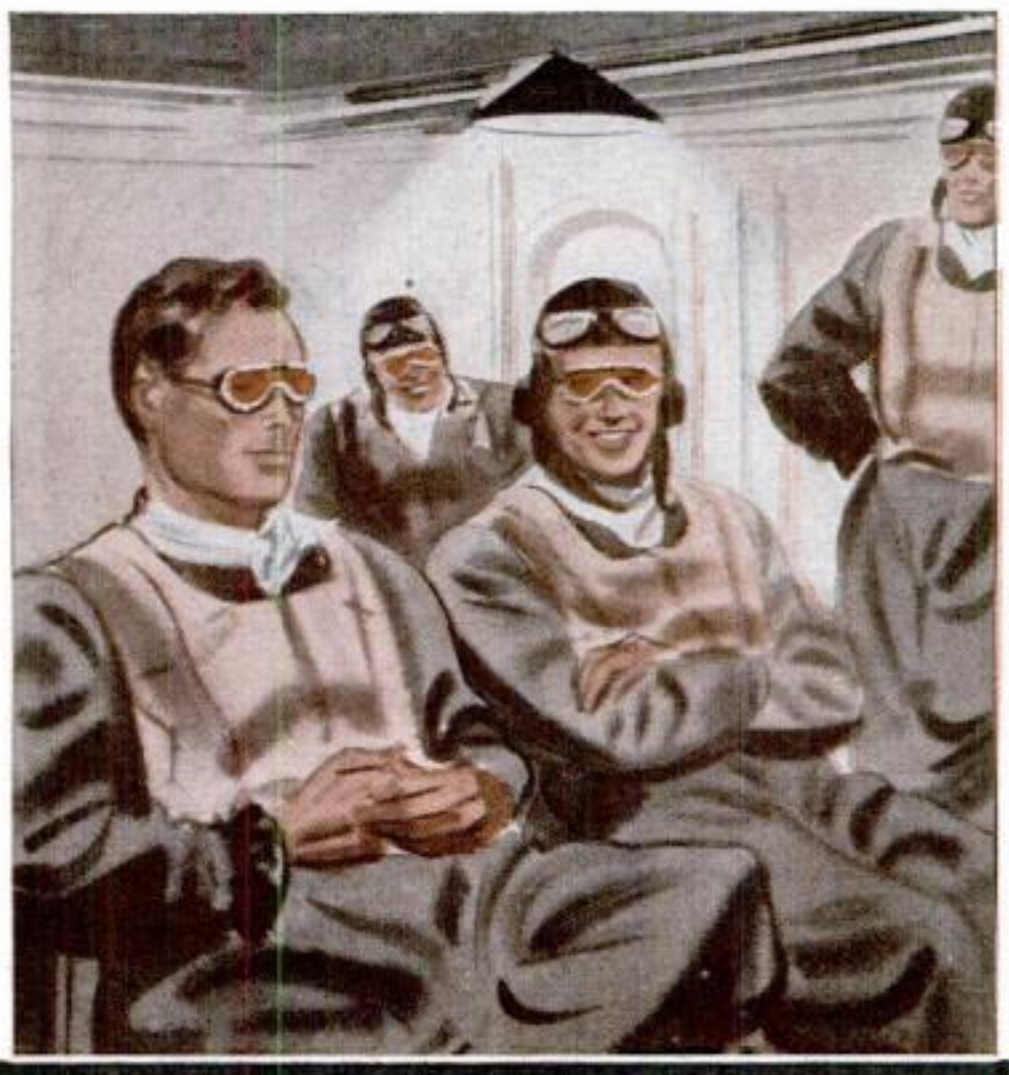
Both civilians and military men may improve the keenness of their night vision. Experiments show that "night eyes" become most sensitive to light just *after* moving. Therefore watchers for airplanes are advised not to scan the heavens with long sweeps of the eyes, but to move them jerkily across the field of view, momentarily stabbing the sky at each stop before proceeding.

To see a very faint star, don't look straight at it, but a little to one side. Known to the ancients, this curious phenomenon applies equally to sighting a pyrotechnic signal, a plane, a tank, or a battleship at night.

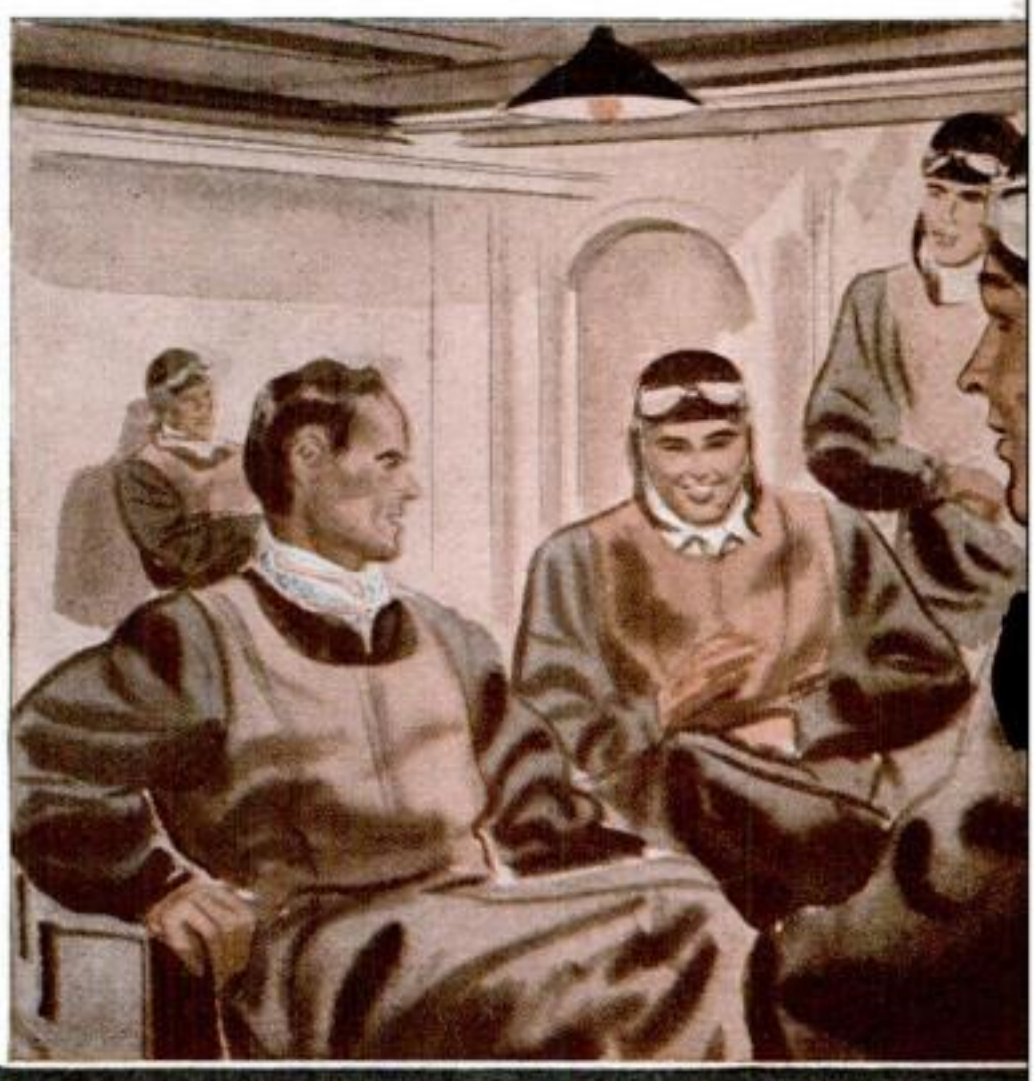
The retina, or light-sensitive part of the eye, which corresponds to the film in a camera, has two kinds of light perceptors on its surface called rods or cones, according to their shape. The cones, which see in colors, serve for daylight vision. Since a large proportion of them are massed in a small spot at the center of the retina, called the fovea, this is the point where day vision is most distinct, and you naturally turn your eyes directly upon an object of interest to bring the fovea to bear upon it.

But at night, the cones quit working. At about the illumination of bright moonlight, their task is taken over by the rods surrounding the center of the eye. The fovea, with its cones, goes practically blind. This explains why looking at an object out of the corner of your eye, and thus bringing its image upon the rods, makes it visible. The rods, although color-blind, can see with but 1/5,000 of the light required by the cones.

VISION CAN BE QUICKLY ADAPTED TO NIGHT FLYING



A better plan is to wear close-fitting goggles with deep red lenses. This gets both eyes ready for instant use



If everybody in the room is waiting for duty, the same effect is obtained by using a deep-red electric bulb

This crystal-clear nose made for a Martin bomber is constructed entirely of "Lucite" methyl methacrylate plastic

LOTS OF THINGS ARE MADE OF PLASTICS—BUT

What Are Plastics Made Of?

By CARL DREHER

GOLD, THEY SAY, is where you find it. A man may discover it or he may miss it; either way he has nothing to do with creating it. Plastics are just the opposite. Plastics are what you make them. You can make them hard or soft, light or heavy, rigid or flexible, opaque or transparent. If you don't like one you try another. Their variety in physical and chemical characteristics is matched only by the diversity of their applications to the machines, devices, and gadgets on which modern living and fighting are based—but always they are materials which are made to order by man, not materials passively accepted as the work of nature.

Plastics are a wide group of organic compounds or resins, largely synthetic, which, under suitable conditions of heat and pressure, can be caused to flow and in that condition be molded or cast into various shapes. There are two general classes: thermo-

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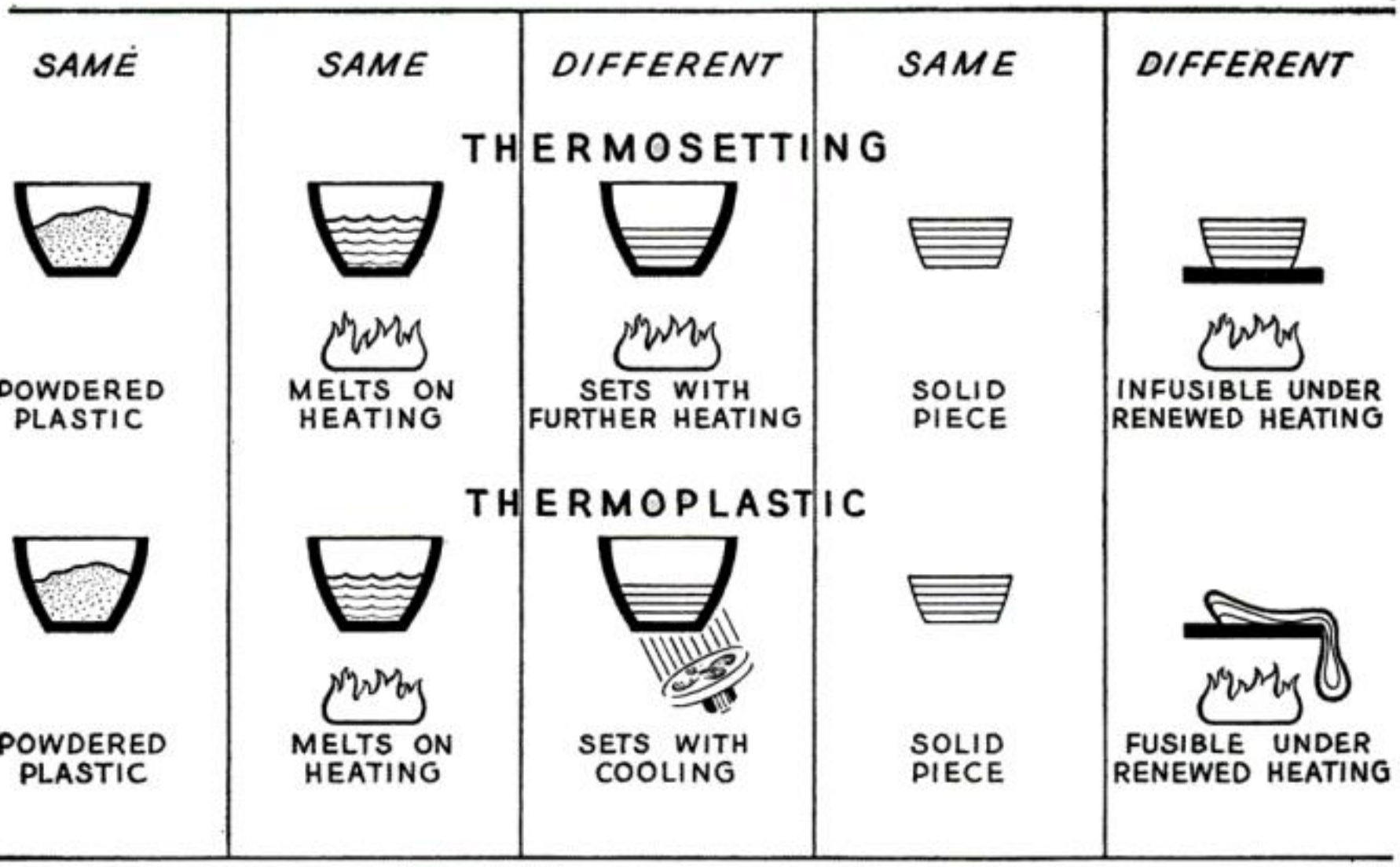
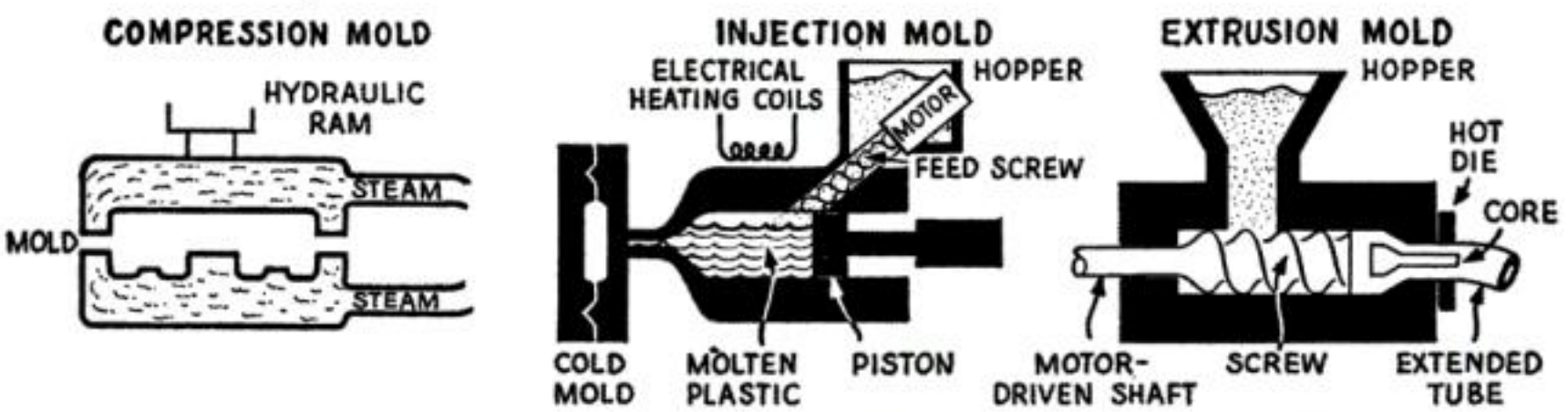
PLASTICS ARE OF TWO TYPES: thermosetting and thermoplastic. The distinction is in the way they react to heat. Both melt when first heated, but on further heating the thermosetting materials harden permanently. Thermoplastics, on the contrary, are hardened by cooling and if heat is applied again they will melt. These properties determine their respective uses



THREE WAYS OF MOLDING PLASTICS: Compression molding employs heat and pressure. In injection molding, plastic is forced through a heated chamber into a chilled mold. Extrusion molding forces it continuously through a hot die, as shown in drawing at right, below



plastic and thermosetting. The principal thermosetting materials are the phenol-formaldehydes, such as bakelite, and the urea-formaldehydes, which are much used in bonding plywood. The thermoplastics include celluloid and similar types, like the cellulose acetates, and also the acrylics, which, being tough, easily curved, and more transparent than glass, are now used in enormous quantities for gun turrets, blisters, and canopies in fighting planes. The difference is in the way the two types behave when heated. Either will melt when heated the first time; they both start as thermoplastics, in effect. On further heating the thermosetting materials harden—for keeps. The thermoplastic materials, on the contrary, are hardened by cooling. If heat is again applied the thermoplastics will melt. Their solidification, in short, is a reversible reaction, while the thermosetting materials are like mortar—once it has turned solid, nothing will liquefy it again.

This difference has practical consequences. Obviously, plastics which in their working locations will be subjected to comparatively high temperatures must be of the thermosetting type. The two types must also be molded in accordance with their thermal behavior. There are three basic types of molding machines—compression, injection, and extrusion—and a hybrid type: the transfer mold. Compression molding, the oldest method, is largely confined to the thermosetting plastics. A compression mold is essentially a press into which plastic material is fed in powdered, granular, or some other divided form. When the

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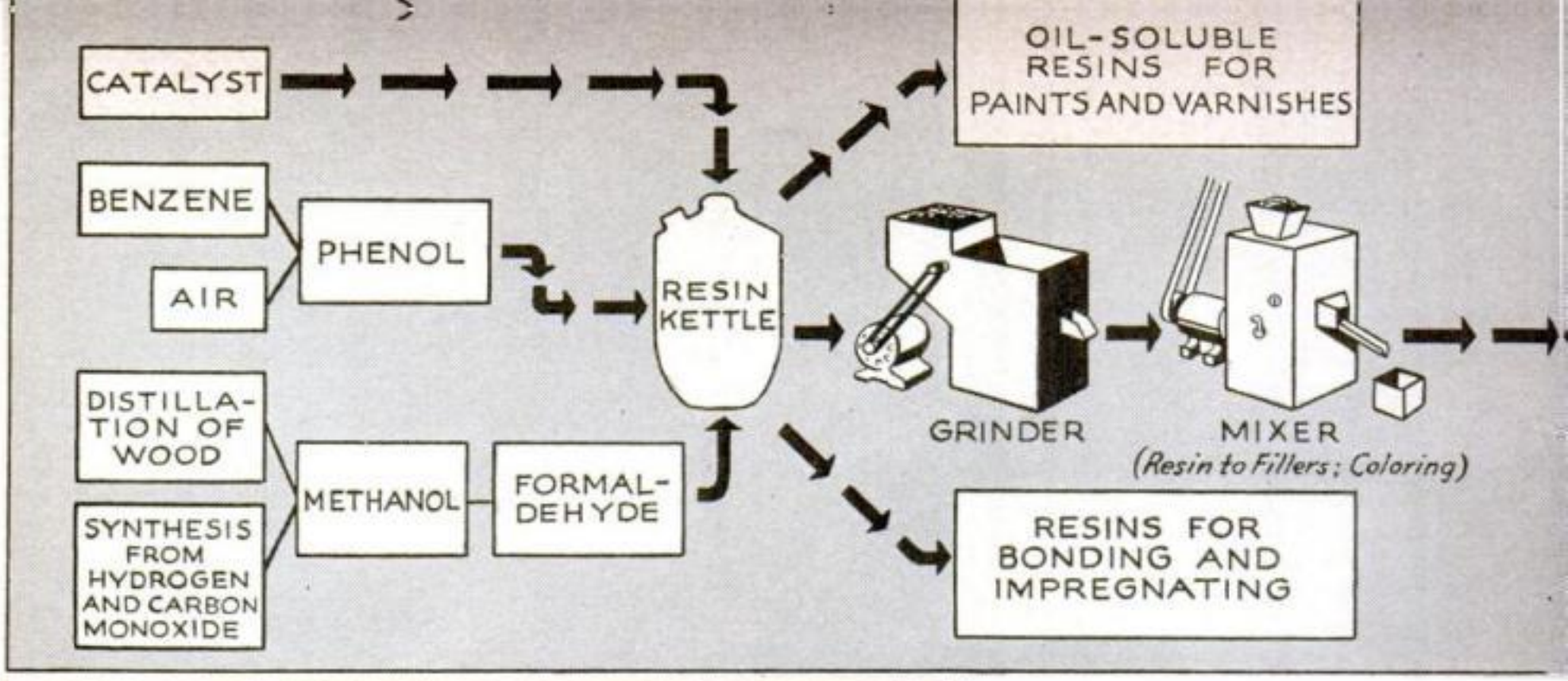
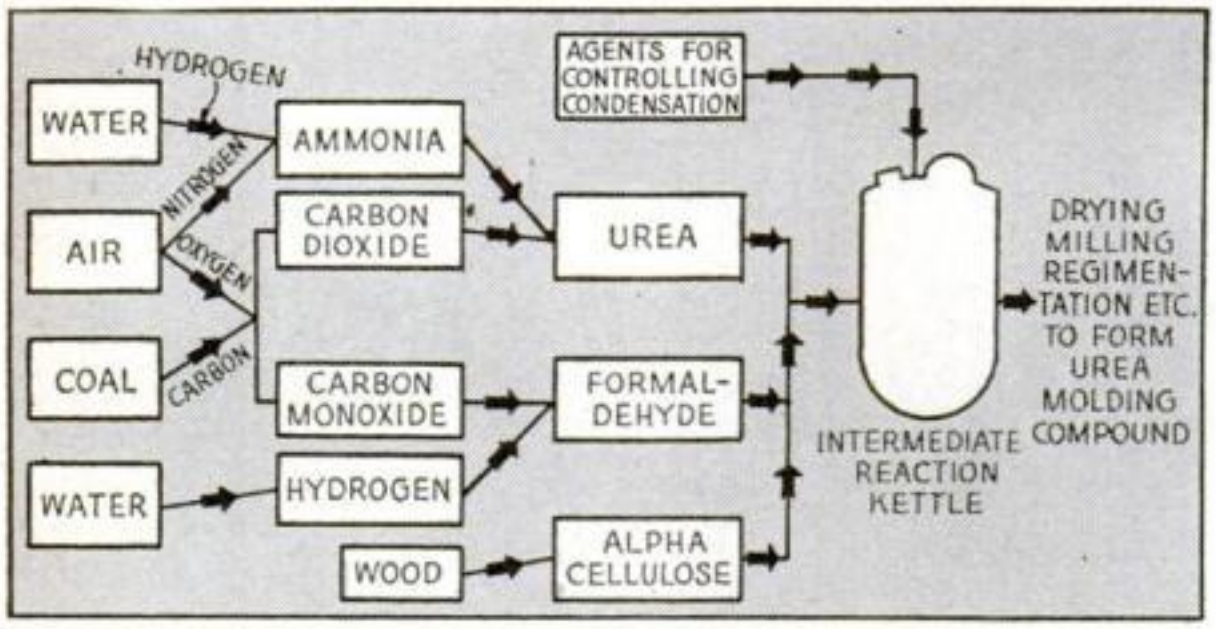
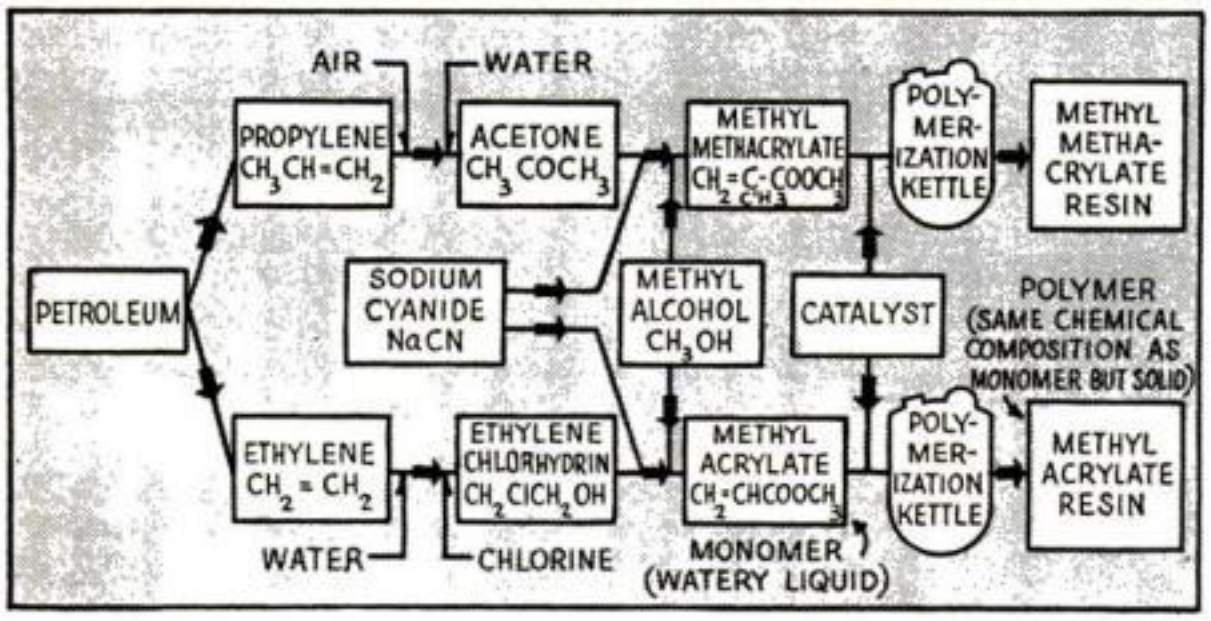




PHENOLIC RESINS are chemically processed as outlined in chart above showing the step-by-step procedure in making plastic powder for molding into products

UREA MOLDING COMPOUNDS are the final result of the chemical sequence diagrammed at left. In somewhat more detail, the chart at the lower left shows the acrylic-resin reaction chain



mold has been filled, it closes, pressure and heat are applied—the former by a hydraulic ram and the latter through a steam jacket—the material flows and takes the shape of the cavity. The mold remains closed until setting takes place. When the piece is fully set, or "cured," it is ejected and the cycle begins all over again.

Thermoplastic materials can likewise be molded by compression, but this method is used only when the parts are too large for available machines of the more efficient injection or extrusion types. On the average, one injection cavity produces as many parts per hour as a dozen compression cavities. Moreover, injection and extrusion molds offer to a greater extent the advantages of automatic operation, which is something to be considered in these days of labor shortages.

In an injection mold, the material is fed from a hopper into an electrically heated cylinder. The mold, consisting of two machined steel halves, receives the molten material through a system of nozzles and gates, pressure subsequently being applied by a hydraulic ram. The mold cavity is kept chilled and the plastic quickly hardens into the finished form. It is then automatically ejected and another "shot" follows. This cycle continues at high speed.

The injection method is comparatively new; the first injection mold was imported into the United States in 1934. At first the capacity was less than an ounce of material per s..ot. Now standard machines go up to 22 ounces and special ones even higher. The outstanding advantage of the injection method is that the heating is done in one place and the compression and cooling in another. This saves time and heat.

An extrusion molding machine operates like a tube of toothpaste squeezed in the hand. The mouth of the tube corresponds to the die which forms the extruded plastic.

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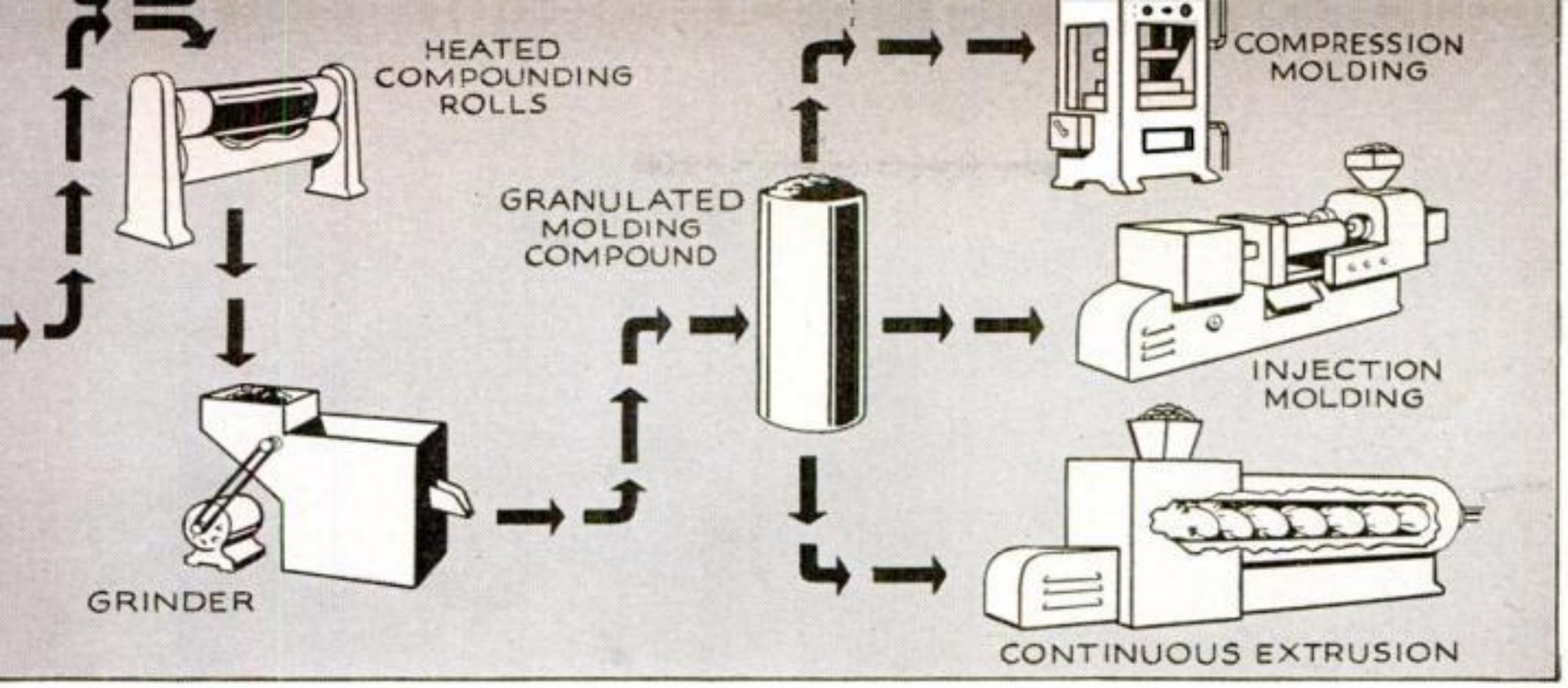

Tear-shaped plastic loop-antenna housings, like that shown at right, are used on many U. S. warplanes, including the famous B-17

The material is carried along by a large screw which operates like that in a butcher's meat grinder. The die is electrically heated and the plastic, as it comes off the die, must be cooled by air or a liquid, carried off on a conveyor belt, and later cut into lengths or wound on drums. The method is over 50 years old—spaghetti was one of the first extruded materials—but has undergone rapid development in the last few years. Costs are low in comparison with compression or even injection molding, one reason being that the process is continuous and fully automatic. The limitation is that only a uniform cross section can be produced, hence the method is best suited for rods, tubes, strips, and filaments. The die may have many apertures, and as many as 16 filaments can be produced at the same time, but they must be kept separate until they cool.

In the transfer mold the material is heated in a plasticizing chamber and forced into the mold cavity through an orifice, or sprue. The subsequent molding is by compression. This method is intended to give thermosetting materials, as far as possible, the manufacturing advantages possessed by the thermoplastics.

Plastic molding is a specialized engineering art involving terrific forces. Since temperatures are over 300° F., and pressures range upward from 3,000 pounds per square inch (in the case of injection molding, up to 40,000 pounds per square inch), lubrication of the principal parts of the mold is impossible. There are many other complications and technological headaches. Molding engineers say that anyone can lay out a mold that will make a good piece; the trick is to get it out intact without the help

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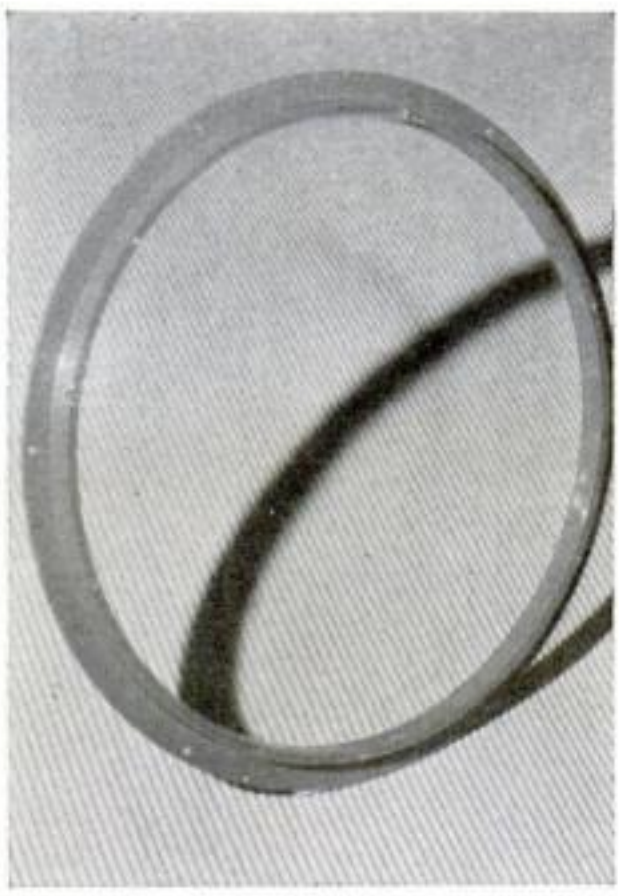
of the nearest dentist. The forces involved are of such magnitude as to strain the strongest materials.

Molding plastics is a business in its own right, but the manufacture of the powdered or granulated materials which are fed into the hoppers of the molding machines is part and parcel of the chemical industries. Practically all the great chemical concerns—Du Pont, Dow Chemical Co., Monsanto, Union Carbide and Carbon, Hercules Powder, American Cyanamid—produce plastic materials from basic ingredients which are equally indispensable for other chemical purposes. Thus methanol or methyl alcohol (CH_3OH), now made synthetically in enormous quantities, is necessary for the manufacture of formaldehyde and hence for production of the phenol-formaldehydes and the methyl acrylic or methyl methacrylate resins already mentioned. But it is equally indispensable for production of military explosives, photographic films, lacquers, insecticides, etc. Similarly styrene ($C_6H_5CH:CH_2$), a co-material with butadiene in the production of Buna S synthetic rubber, also forms the polystyrene plastics.

One of the illustrations shows, in a very sketchy way, the chemical processing of the phenolic resins. Beginning at the left, we note that first phenol or carbolic acid (C_6H_5OH) is evolved from benzene and air, or from coal tar, and reacted with formaldehyde (HCHO) in a resin kettle under heat and pressure in the presence of a catalyzer—a chemical which facilitates reaction without undergoing any change itself. Oil-soluble resins for coatings are taken off, also resins for bonding and impregnating. The remainder, with the consistency of molasses, is poured out on a steel floor and allowed to cool. Then it is broken into lumps, crushed and ground into powder, and mixed with a filler such as wood flour (ground wood or sawdust) or, in some cases, walnut-shell flour. Subsequently it is heated and rolled, ground again, screened and blended with other batches to insure a uniform product, and finally we have the plastic powder which is fed into the hopper of the molding machine.

There are numerous modifications of this process. Instead of phenol, other related compounds like cresol may be used. Another alternative material is furfural, obtained from waste farm products like oat hulls, corncobs, rice hulls, etc. The Ford Motor Company incorporates soybeans and other farm products in its phenolic plastics. These are examples of chemurgic applications, and they are extremely important at the present time to relieve shortages. Lignin pulp, among other materials, may be used as an "extender" to make the available plastics go a longer way. A relatively small percentage of phenolic resin, mixed with ground lignin pulp, makes a usable plastic. The molding cycle, however, is longer.

The acrylics are used not only in place of glass in airplanes, but as dental material (according to one estimate 90 percent of the dental plates made in the United States are fabricated of methyl methacrylate), as surgical and dental illuminating instruments for piping light around corners by internal reflection, and for countless nonessential purposes—musical reeds, costume jewelry, toilet articles, pipe stems—which are now of the past or had better be very soon. Then there are the vinyl ester resins; the vinyl acetals; the recently introduced vinylidene chlorides which, among other applications, make ropes, tough fabrics for seat covering in public conveyances, and the like; the styrenes; the cellulose materials which are still among the most important plastics and include nitrocellulose and cellulose acetate; the polyterpene hydrocarbon resins used in the rubber industry; casein and other plastics made from animal and vegetable proteins. And that is a very incomplete listing.



An all-plastic window. Frame is of Lustron; window of cellulose acetate

Practically all of these plastics have wartime uses. Plastics will not win the war, but without plastics we might conceivably lose it. As early as 1940 half of the plastics production was in the industrial field. Even the frivolous, gadgety, and nonessential applications of pre-Pearl Harbor days were not wholly a waste. They gave the customers a good time, and they taught the plastics people what their products could and could not do. This experience proved invaluable when the task of wartime conversion had to be tackled. From a plastic toaster base to a plastic trench-mortar fuse was less of a jump—

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even if the same material could not be used — because millions of toasters had been manufactured. Bomber turrets came from transparent cases for playing cards, cigarettes, and lipsticks. When the bugles sounded lots of glamour plastics went to war and went fast. Others, like playboys with more patriotism than stamina, needed a physical build-up before they could interest the recruiting sergeant.

It must not be imagined that the innumerable applications of plastics in the war industries are accepted mostly for want of anything better. If you want to get a rise out of a plastics manufacturer, just refer to his product as a "substitute." The reason is, of course, that people have come to think of substitutes in the special sense of *ersatz*. If I can't have bread, O. K., I'll take sawdust. That connotation does a real injustice to plastics, which in many cases are actually just as good as the materials they replace, and in others, distinctly better.

The plastic fuse that this girl is holding in her right hand replaces a pound of valuable aluminum in making a trench-mortar projectile

One reason for the extensive use of plastics for transparent enclosures in military and naval airplanes is that the stuff is not only easily formed to any desired shape and strong enough to withstand speeds of over 300 m.p.h., but weighs less than half as much as glass. Properly designed plastic parts often effect other material savings in weight in aircraft: it is said that the radio apparatus on the German Messerschmitts weighs twice as much as comparable American equipment, partly because we use plastics freely while the Germans tend to stick to ceramics. A plastic antenna base for the P-39 Bell Airacobra weighs only 15 ounces. The direction-finder loops which guided American planes to Tokio were plastic-enclosed. Among structural materials the resin-bonded plywoods are of great importance, both in training planes and in some parts of combat planes. Aircraft flooring and partitions, parts of the bomb-release system, equipment-support brackets, and other secondary structural members may be molded from rag or fiber-filled phenolic plactics, which are usually stronger than plastics made only with powdered fillers. Pilot seats of cotton fabric, impregnated with a plastic varnish and molded into rigid shape, save weight and aluminum. A substratosphere oxygen mask contains no metal, only rubber and phenolic plastic, which is light, durable, and unaffected by low temperatures. Then there are the usual nonstructural applications—insulation, instrument housings, knobs and handles. At airports, the radio sonde, which is a weather recording station and radio transmitter sent aloft under a small balloon, uses urea plastics because they are light in weight, strong, and non-water-absorbent.

On the ground we may still have to reckon with brass-hat mentality here and there. But we won't have the brass hats because we haven't got the brass. The generals will have to wear plastic helmets like the privates, and they will be good helmets—good enough to withstand an eight-pound iron ball dropped a distance of two feet, or a one-pound hammer dropped 16 feet. For combat service a metal cover will increase the stopping power from 16 foot-pounds to 50 foot-pounds. Soldiers' helmets must withstand high temperatures during delousing treatment. These plastic helmets may be exposed to steam at 250 degrees F. for 30 minutes without damage.

Ordnance applications include experimental use of plastics for rifle stocks. So far they are said *(Continued on page 218)*

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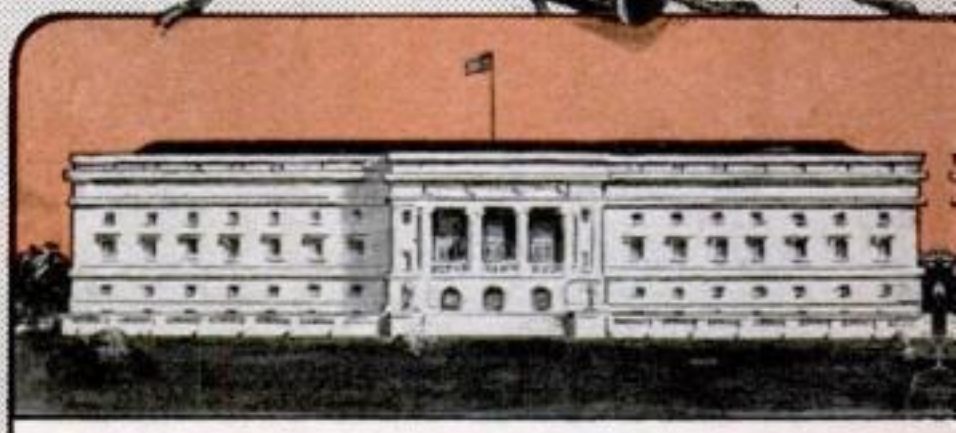
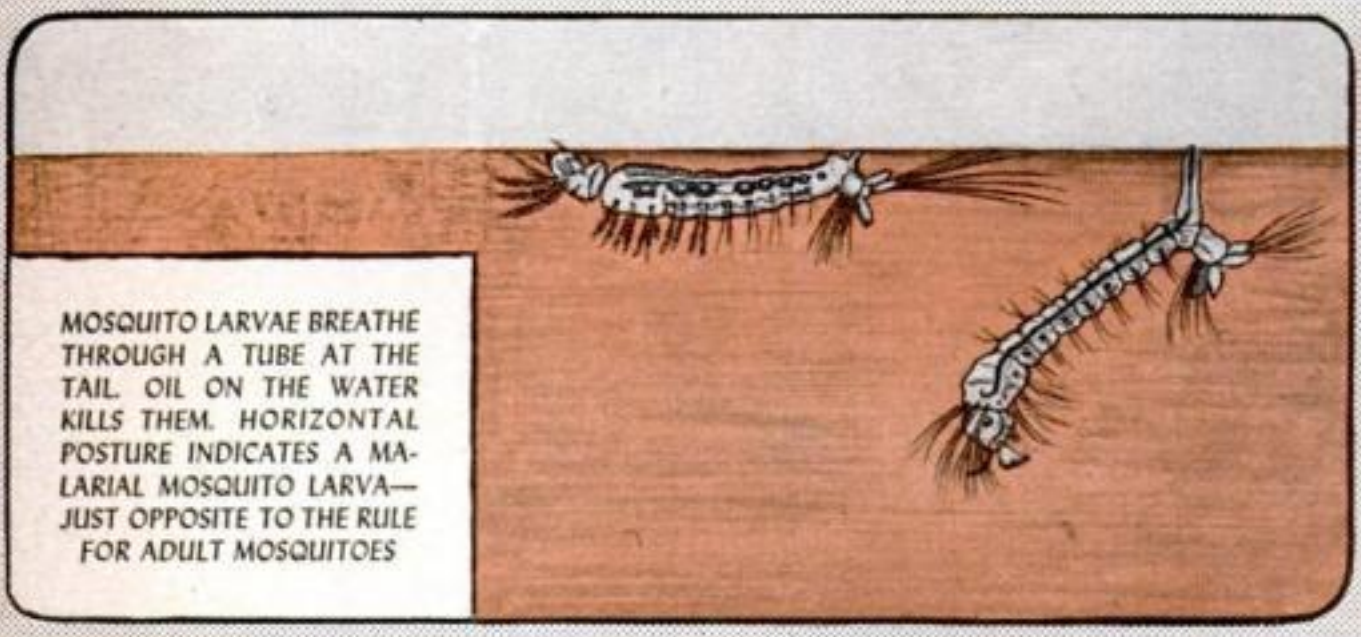
There are more than 500,000 different species of insects — one for each of the tiny dots making up this gray panel. Yet only about 50 — represented by red dots in the magnified section — are important disease carriers. These include the malaria-bearing Anopheles mosquitoes

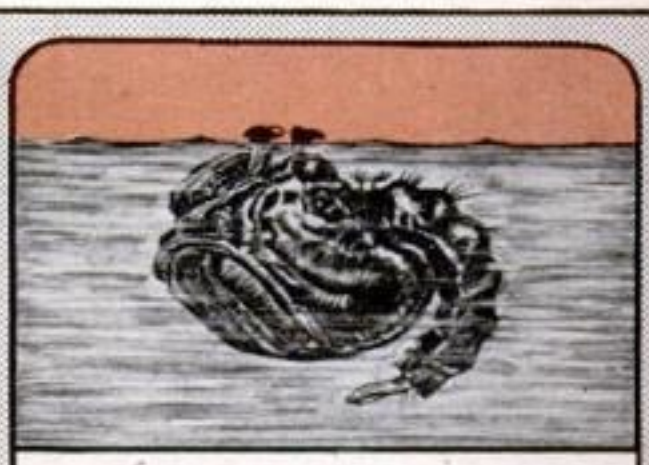
MALARIA IS A WORLD-WIDE DISEASE WITH SERIOUS FOCI IN ALMOST ALL HOT COUNTRIES. IT IS ENDEMIC IN 17 STATES IN THE UNITED STATES



IT WAS ONCE ESTIMATED THAT THE MONEY LOST EACH YEAR THROUGH MALARIA IN THE UNITED STATES WAS TWO AND ONE-HALF TIMES THE ANNUAL OUTPUT OF THE PHILADELPHIA MINT



MOSQUITO LARVAE BREATHE THROUGH A TUBE AT THE TAIL. OIL ON THE WATER KILLS THEM. HORIZONTAL POSTURE INDICATES A MALARIAL MOSQUITO LARVA—JUST OPPOSITE TO THE RULE FOR ADULT MOSQUITOES



THE PUPA BREATHES THROUGH TWO FUNNEL-SHAPED ORGANS AND CAN ALSO BE KILLED BY OIL

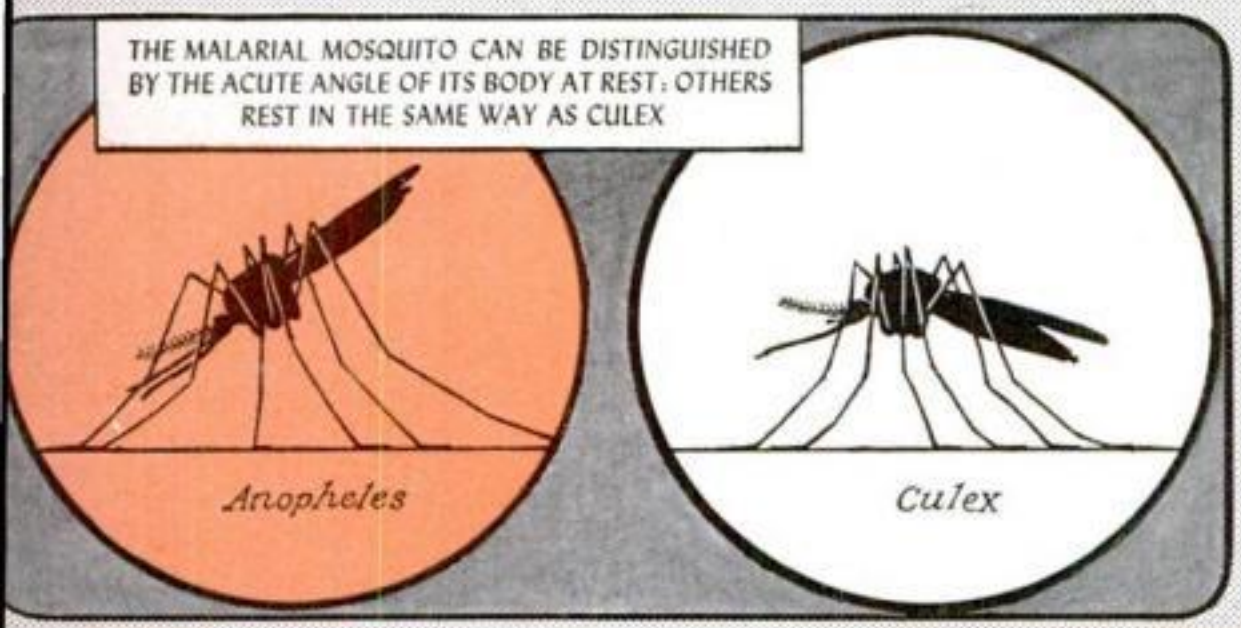
THE CHIEF DANGER IS AT DAWN AND DUSK. WHEN THE MOSQUITOES ARE IN FLIGHT NETTING AND GLOVES GIVE PROTECTION OUTDOORS; SCREENS KEEP HOUSES SAFE

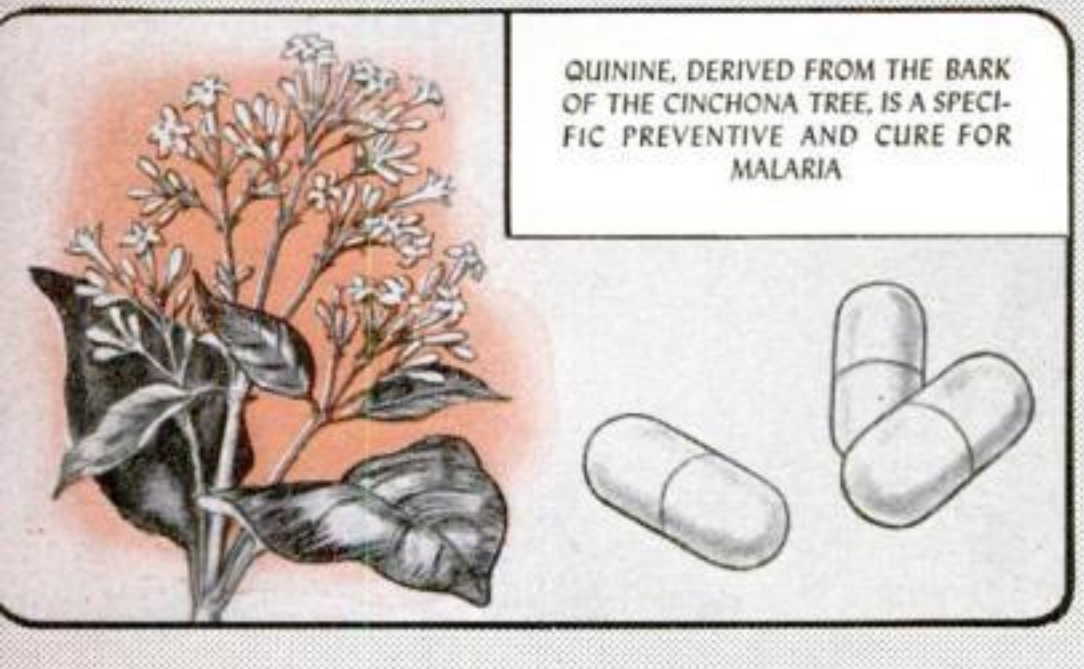
BAT ROOSTS WERE ONCE BUILT TO ATTRACT BATS IN THE HOPE THEY WOULD REDUCE THE POPULATION OF MALARIAL MOSQUITOES, BUT WITHOUT REAL SUCCESS. DRAGONFLIES, HOWEVER, ARE CALLED MOSQUITO HAWKS AND DO CURB MALARIA

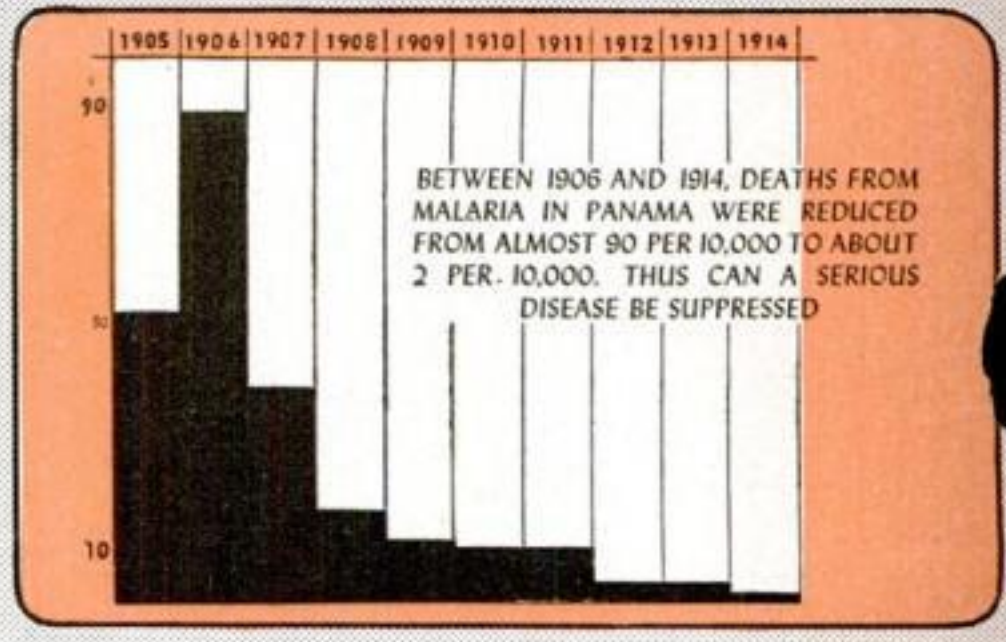
How Science Is Battling The Fever Mosquito

MALARIA, which kills more than 3½ million persons every year, is an aerial blitz inflicted on man by the Anopheles mosquito. It has a higher sickness and death rate than any other disease. Tropical medicine, operating against it in its favorite haunts, the Orient and the tropics, has developed scientific methods of prevention and cure. With large bodies of troops from temperate climates fighting in the malarial danger zones in the present war, this research will save thousands of our fighters from the worst of all their enemies.

Drawings by Harry R. Daugherty
from "Natural History" Magazine







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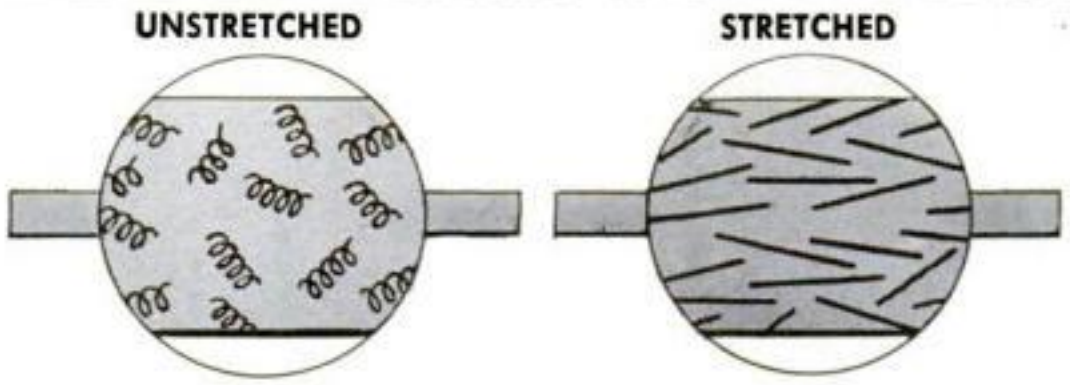
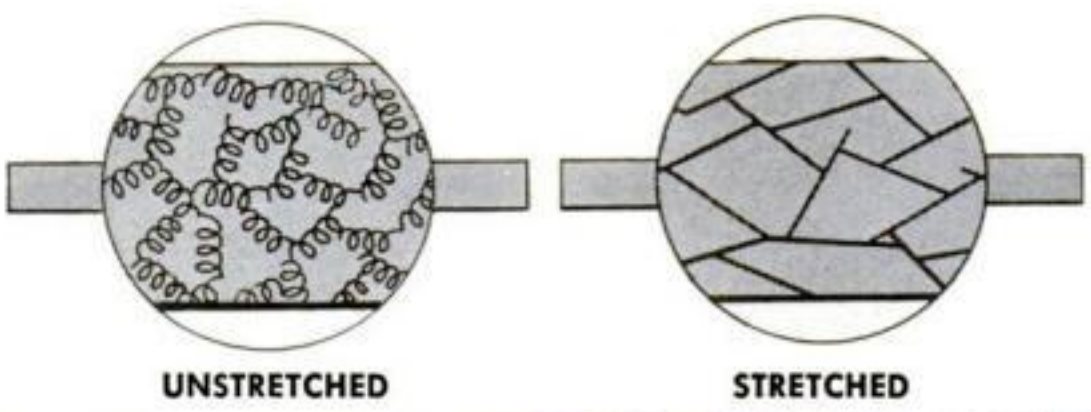
WHAT MAKES RUBBER STRETCH?

CRUDE RUBBER

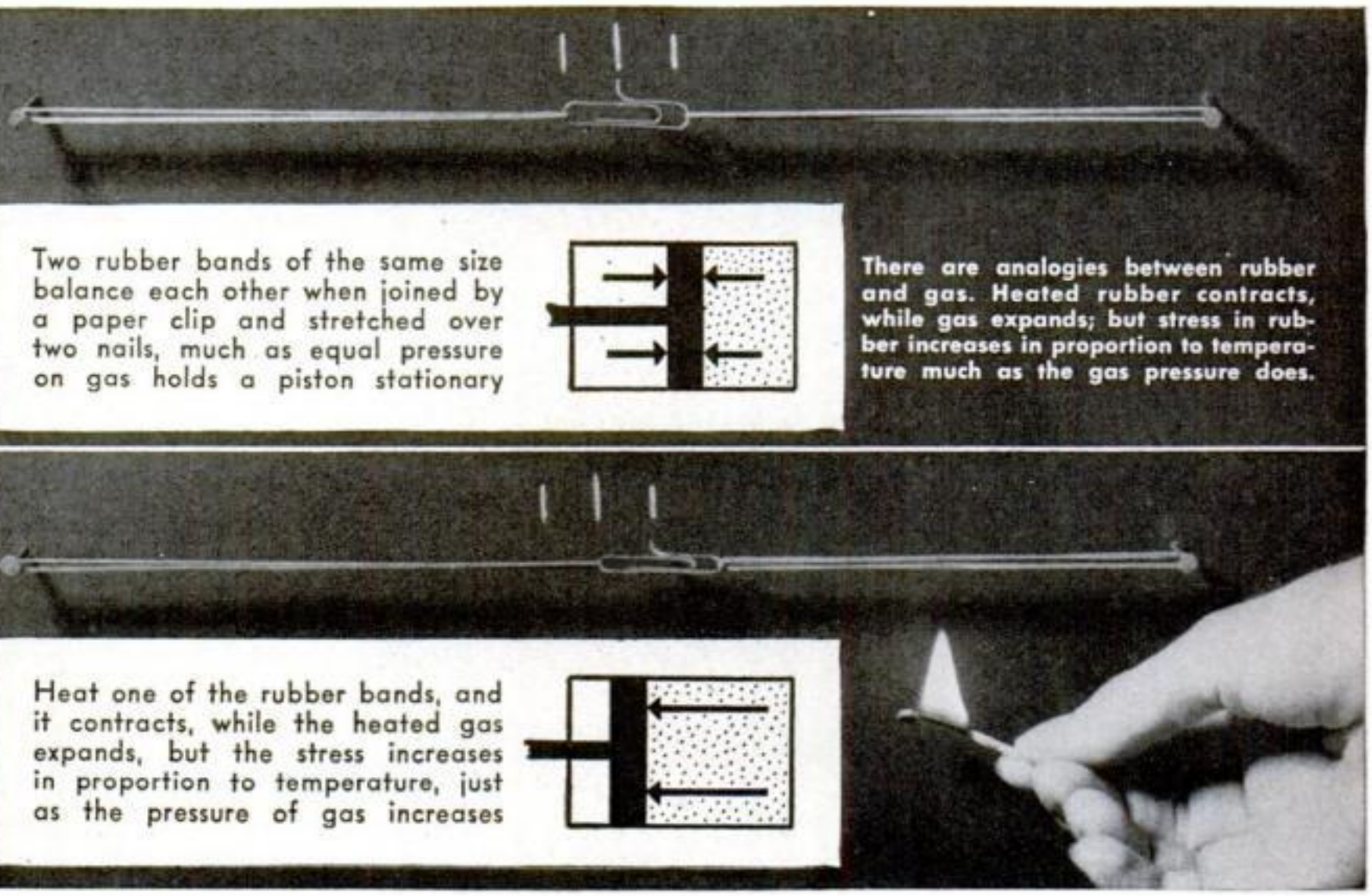


Rubber molecules are normally coiled like springs, according to a new theory, and straighten out when stretched. In crude rubber, these tiny coils do not touch, and consequently they slip slightly during stretching. This is why crude rubber never returns fully to its original length after being stretched

VULCANIZED RUBBER



Vulcanizing changes this set-up in rubber, binding the coiled molecules together into a more or less flexible net, something like springs hooked together in a flat-spring bed, and they no longer slip. Vulcanized rubber will stand an amazing amount of stretching without disturbance of this molecular arrangement



Two rubber bands of the same size balance each other when joined by a paper clip and stretched over two nails, much as equal pressure on gas holds a piston stationary

There are analogies between rubber and gas. Heated rubber contracts, while gas expands; but stress in rubber increases in proportion to temperature much as the gas pressure does.

Heat one of the rubber bands, and it contracts, while the heated gas expands, but the stress increases in proportion to temperature, just as the pressure of gas increases

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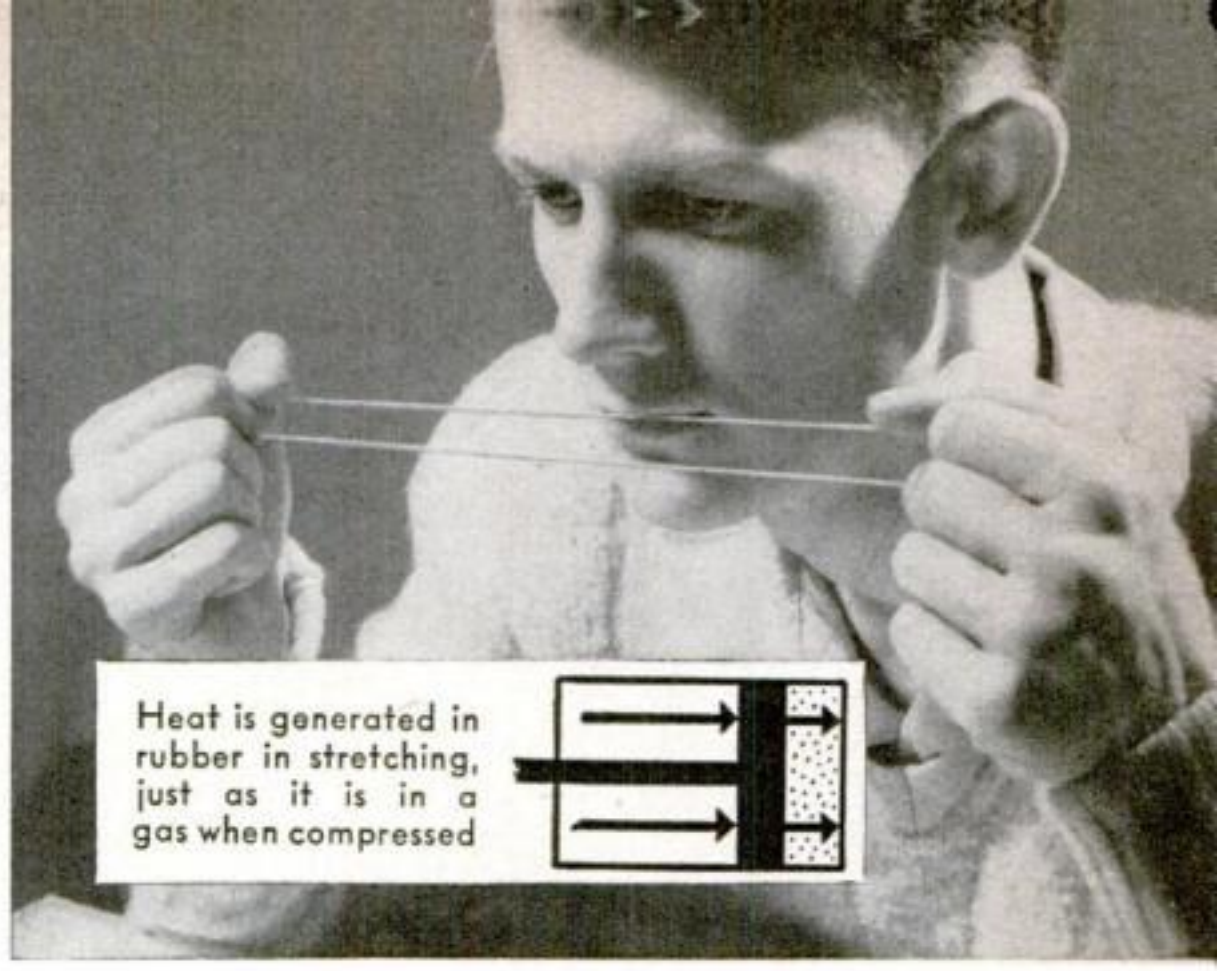


STRETCHED RUBBER GENERATES HEAT as gas does when it is compressed. To test this, stretch a small rubber band quickly to ten times its length, touch it to your lip, and feel the warmth. Release the tension suddenly, and it will feel cool to the lip. Likewise, gas heated by compression will cool off when the pressure is returned to normal

WHAT puts the bounce in rubber, or causes it to snap back when stretched, is a fascinating subject to science and industry alike. The solution may mean still better synthetic substitutes with the elasticity necessary for tires, tubes, balls, and hundreds of other rubber products.

One theory—revealed recently by Hubert M. James, of Purdue University, and Eugene Guth, of the University of Notre Dame, before the Division of Rubber Chemistry of the American Chemical Society—compares the molecules of rubber to coiled springs. In crude rubber, these molecules slip past each other, and the rubber does not return altogether to its original length; but vulcanizing binds them together into a flexible net.

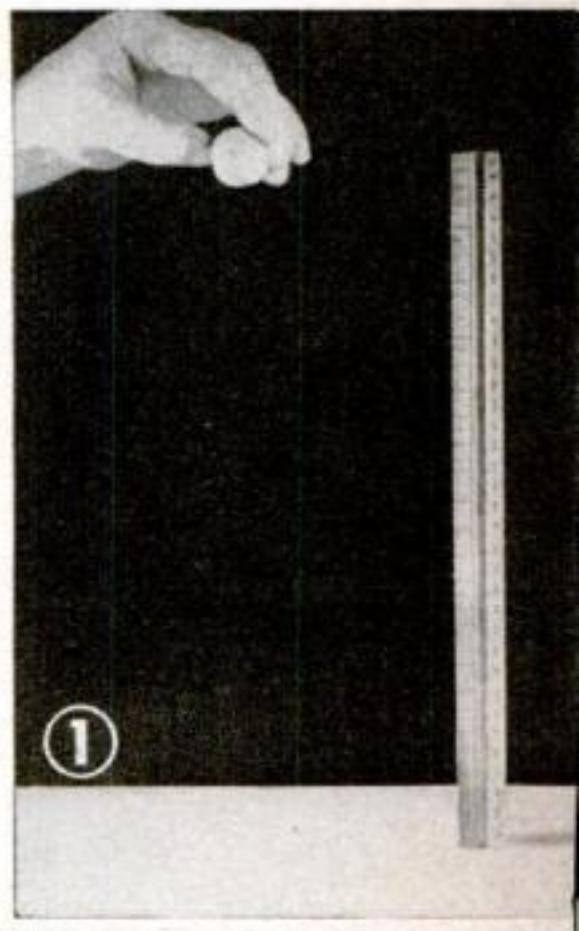
James and Guth also compare rubber with gases under pressure, and suggest several experiments. For example, a rubber band stretched quickly to ten times its length feels warm when touched to the lip; released, it feels cool. The heat generated is similar to that of a compressed gas; the cooling, to that when pressure is released. Likewise, when a stretched band is heated, the stress in the rubber—either synthetic or natural—increases in proportion to temperature much as the pressure on a piston increases as gas in a cylinder is heated. At room temperature, a ball of butyl rubber hardly bounces, but at 100 degrees centigrade it bounces as high as one of natural rubber.

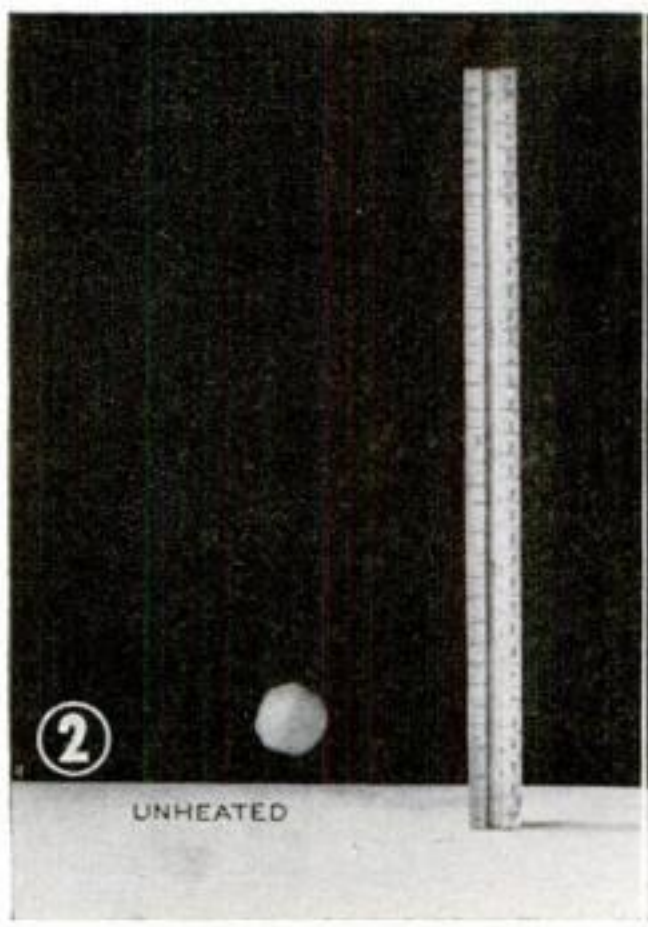
HEAT GIVES SYNTHETIC RUBBER BOUNCE IT NORMALLY LACKS

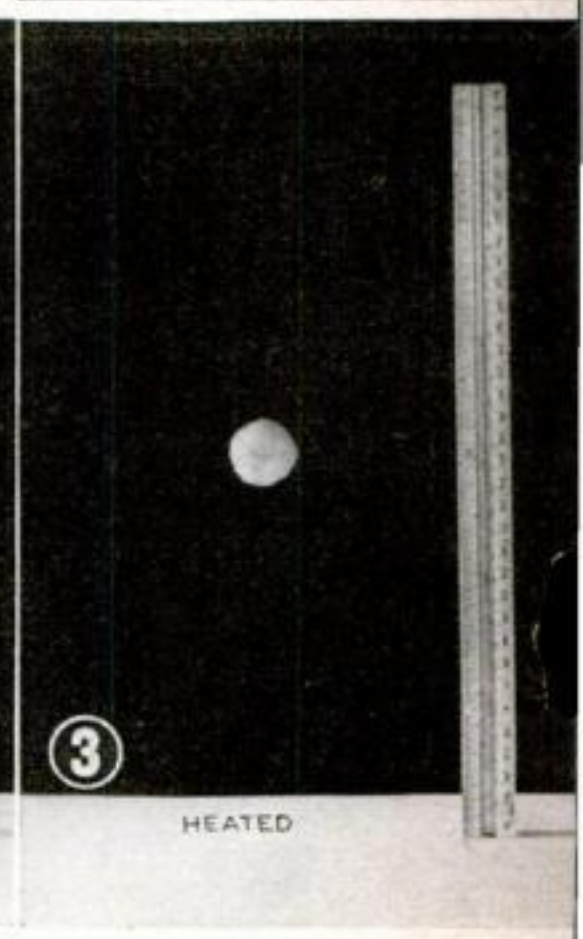
1 Hold a ball of synthetic butyl rubber a foot from the top of a table, and allow it to drop in this test of its ability to bounce

2 If the butyl ball is at room temperature, it will bounce hardly at all—possibly an inch

3 But if the ball is heated to 100 degrees centigrade, it will bounce about six inches, or half the distance it has dropped. This compares favorably with the bounce in natural rubber. When more is learned of the reasons, it is possible that butyl rubber more lively at ordinary temperatures will then be very quickly produced







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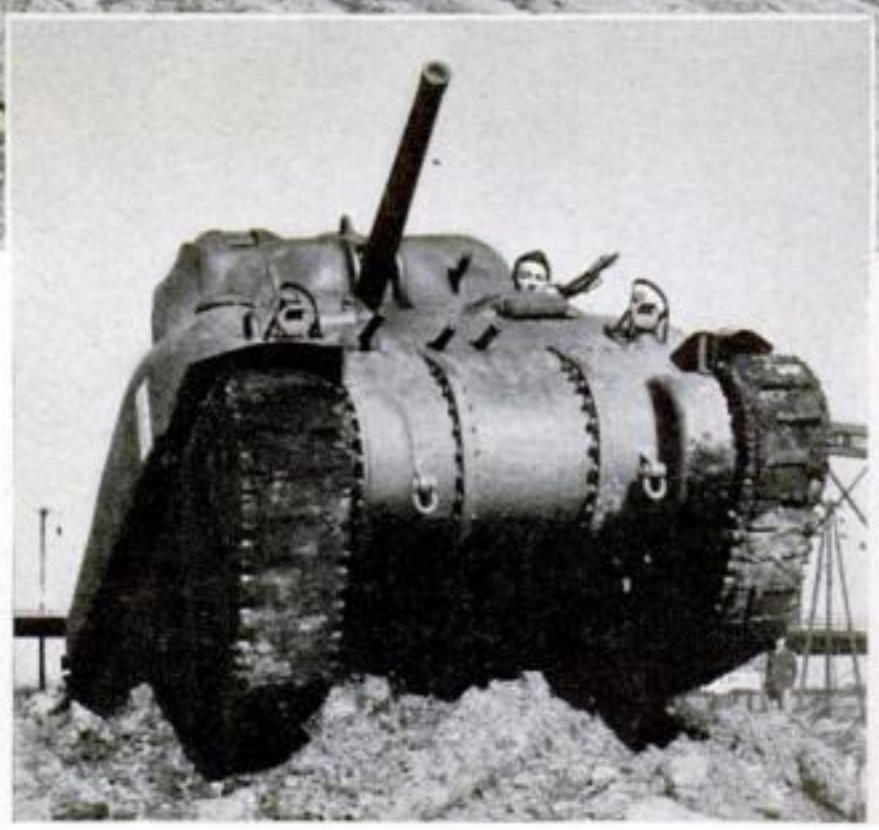

MORE LARGE CASTINGS, and fewer parts to be riveted or welded, are the latest development in the newest "General Lee" medium tank, the U. S. Army's M-4 A 1, which gains still more strength in the changed design. Turret and hull are both one-piece castings as in the previous model, and in addition the lower front section is now also cast in one piece, as can be seen above in the photo of four of the new tanks. This front section on the older M-4, which is shown at the right for purposes of comparison, was cast in three pieces.

JEEP BLACKOUT LAMPS are being made with plastic lenses that admit the passage of enough light for driving but not enough to be seen from planes. The lenses fit into stamped metal housings serving as auxiliary head and tail lamps on Army vehicles. They are constructed of the same almost unbreakable plastic material used for bomber noses, airplane gun turrets, and cockpit covers. A new jeep headlight is shown at the extreme left, and, next to it, a taillight.

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of the Materiel Division of the Air [illegible] continued to govern the military characteristics [illegible]

—from "Victory Through Air Power," by Major Alexander P. de Seversky

aeronautical industry and to [illegible] well known to the leaders. But it required another "fortunate disaster"—the immeasurable tragedy of another World War—to bring the facts into the public light. The war startlingly disclosed that while we possessed many airplanes with first-rate flying characteristics, we had practically no *military* airplanes in the real sense of the word. It would be an insult to the dictionary to designate as "military" craft so deficient in the basic qualities necessary for combat.

The industry should not, in justice, be made to shoulder responsibility for that. It had been besieging the War Department, year after year, with bold and practical military ideas. Our engineers and designers and aviation salesmen discovered soon enough that they only invited the displeasure of the military higher-ups—even to the point of risking

Listen, Major de Seversky—

When you talk about military aircraft, you have to consider two things: First, how well each type performs the job for which it was designed; second, how that job fits into the war you are fighting. *Our military planners outguessed the Axis by foreseeing a global war and building planes to suit it.* Comparisons of specific U. S. planes with specific Axis planes mean nothing except with reference to their respective tasks and the way they fit into the pattern of victory. Measured by this yardstick, our aircraft show up well. Fighting on many fronts, they have in most cases proved superior to the enemy's. Designed in the years of peace and modified by the lessons of war, they have given a splendid account of themselves. The box score on the following pages tells the story. History may record that the world's greatest war was won on American drafting boards.

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Wings of

"The value of an airplane is judged by its success in completing the mission it is designed to perform. No single airplane can fulfill all military missions, but each must be designed to do its own specific task well. The airplane that

THIS IS THE YARDSTICK AGAINST WHICH

By WILLIAM S. FRIEDMAN

ARMCHAIR AVIATORS, high-altitude radio commentators, and literary strategists have, in the last few months, managed to throw the public mind into a dither of doubt as to the value of our military aircraft. Their chief weapon has been comparison—the quotation of figures which have made some of our planes appear third-rate. The public, untrained to weigh evidence in this highly technical field, has been given the wholly unwarranted impression that Uncle Sam is sending his air crews out to meet the enemy in inferior ships.

The industry producing aircraft has been too busy to refute these comments; the Army has rightly declined to reply to them. Both prefer to allow the military record of the nation's aircraft to make its own answer. Unfortunately, however, the very information which would vindicate our military seers, designers, and builders happens to be of highly confidential nature. For the time being it is more valuable to the enemy than it is in the hands of the average layman. Perhaps it would be better to present the average citizen with his own yardstick against which he can measure the success or failure of the aircraft that are being produced for his protection.

The fate of the world is being decided in the field of military conflict. The outcome of this conflict is, in a large measure, being

"The record of American aircraft is generally that of having completed the tasks for which they were designed."
BRIG. GEN. CLAIRE CHENNAULT

P-40 Our foot-in-the-door fighter. Never totally outclassed on any front, it has always given heavier losses than it took

P-47 Literally tops in high-altitude fighters. Beats the touted Focke-Wulf 190 by nearly 10% in speed, 5% climb, 12.2% service ceiling

A-20 As a hedge-hopping bomber, it harries troop movements and tanks. As a night intruder in France, it literally played Havoc

B-26 Called the world's fastest bomber in any class, it can outrun most fighters. Carried torpedoes at Midway and in the Aleutians

B-17 Has more completed missions to its credit than any other bomber. Gets more fighters per scrap than most pursuits

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Victory

does this may be considered a highly successful tactical weapon."—Major General Oliver P. Echols, Commanding General, Materiel Command, U. S. Army Air Forces.

OUR ARMY PLANES ARE TO BE JUDGED

decided by air power. The success of an air arm depends upon how well its aircraft are fitted to perform the tasks set for them by the pattern the conflict has taken. This fitness depends on how shrewdly our military planners guessed many months before.

In a large measure, the Axis has lost a phase of this war, despite a measure of territorial success, owing to what was probably the worst guess in history.

The Luftwaffe, originally, was a short-range army co-operation machine geared to act as artillery over a front 50 to 150 miles deep. It rolled over Poland like a tidal wave. If it had kept going, it might have caught Russia with its air-power down. Instead, the tidal wave turned and swept over an aeronautically unprepared France. At the end of this collapse, the Luftwaffe ran into the first correct guess on the side of the United Nations—the Hawker Hurricanes and the Supermarine Spitfires.

In 1935, Sir Hugh Dowding, Chief Air Marshal, called for open bids on a fast, rocket-climbing, eight-gun ship, capable of outspeeding and outmaneuvering anything on wings. Its rate of fire would make it poison to anything capable of operating over a longer range than its own. Virtually everything was sacrificed for speed, climb, and maneuverability and fire power. At the evacuation of Dunkirk and the bitter battle for Britain, the Luftwaffe measured up to the specifically ordered job only eight inches to the R.A.F.'s 12 on the ultimate scale of comparison. Swarms of aircraft invaded the island, only to be driven off. The early Junkers JU-87, the Dornier DO-17

P-38 Fastest combat plane in active service today, it stands high on the Luftwaffe's "duck this one if you can" list. A pilot's pet

P-39 That 37-mm. cannon in the Airacobra's nose has smashed tanks, emplacements, submarines, big planes. Hell on landing boats

B-24 Italian naval and supply vessels have been hugging the shore since this big bomber, much like the Fortress, got after them

B-25 First to bomb Tokio; first to sink a sub in the Atlantic; bombed Japs in the Philippines. Easiest to fly of all our bombers

P-51 Designed on the basis of war experience for close co-operation with the ground forces, it caught the Nazis without a defense

A-31 Built to out-Stuka the Stuka. Carries a heavier load than any other Army dive bomber. Can be used as a low-level bomber

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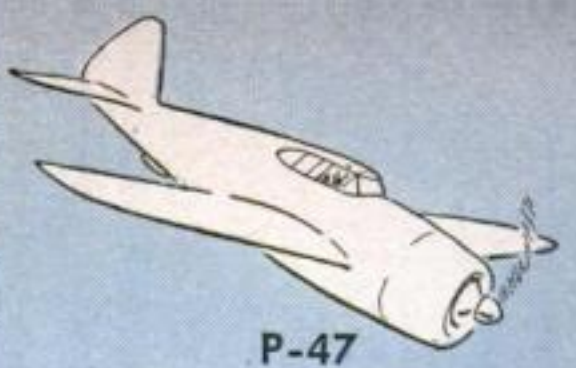
What You'll Want to Know About Our Army Planes

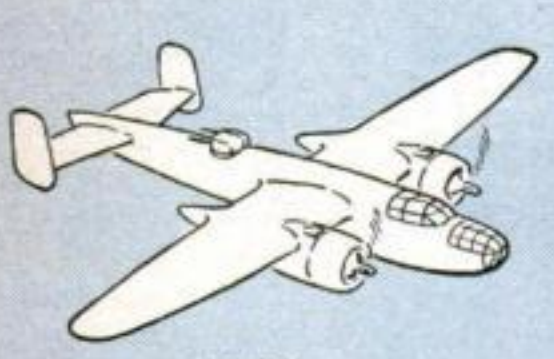
B-17
BOEING FLYING FORTRESS

Power Plant: 4 1,200-hp. Wright Cyclones; Span: 110'; Length: 63'; Height: 19'; Weight: 48,000 lb.; Speed: 300 class; Ceiling: 42,000+ ft.; Range: 2,100 mi. (app.); Bomb Load: 3½ tons; Armament: 10 or more guns of mixed caliber



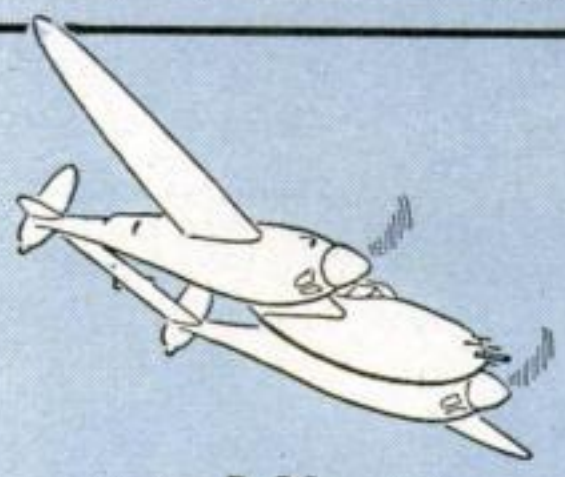
P-47
REPUBLIC THUNDERBOLT

Power Plant: 2,000-hp. Pratt & Whitney; Span: 40'; Length: 35'; Height: 12'8"; Weight: 13,500 lb.; Speed: 400 class; Armament: 6 or more .50 cal. machine guns



B-25
NORTH AMERICAN MITCHELL

Power Plant: Total 1,700 hp.; Span: 67'6¾"; Length: 54'; Height: 15'; Weight: 24,000 lb.



P-38
LOCKHEED LIGHTNING

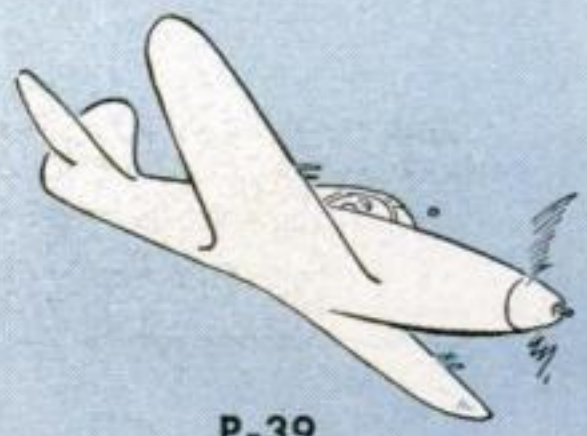
Power Plant: 2 1,150-hp. Allisons; Span: 52'; Length: 37'11"; Height: 9'10½"; Weight: 13,500 lb.; Speed: 400 class; Armament: 4 .50 cal. machine guns, 1 37-mm. automatic cannon

P-51
NORTH AMERICAN MUSTANG

Power Plant: 1,150-hp. Allison; Span: 37'; Length: 32'; Height: 8'8"; Weight: 7,700 lb.; Armament: 6 .50 cal. machine guns

B-26
MARTIN MARAUDER

Power Plant: 2 2,000-hp. Pratt & Whitneys; Span: 65'; Length: 58'3"; Height: 19'; Weight: 26,625 lb.; Speed: 300 class

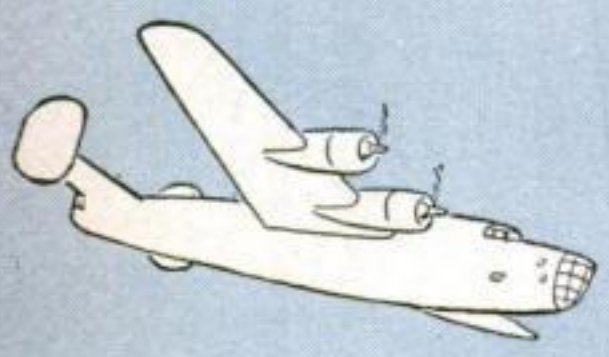


P-39
BELL AIRACOBRA

Power Plant: 1,150-hp. Allison; Span: 34'; Length: 29'9"; Height: 9'3"; Weight: 7,400 lb.; Speed: 300 class; Armament: 1 37-mm. or 20-mm. cannon, about 4 .50 cal. machine guns

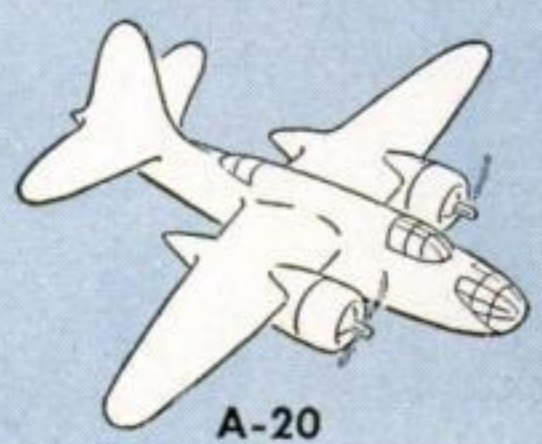
A-31
VULTEE VENGEANCE

Power Plant: 1,600-hp. Wright Cyclone; Span: 48'; Length: 54'; Height: 15'; Weight: 12,939 lb.; Speed: 300 class



B-24
CONSOLIDATED LIBERATOR

Power Plant: 4 1,200-hp. Pratt & Whitneys; Span: 110'; Length: 63'; Height: 19'; Weight: 43,000 lb.; Speed: 300 class; Bomb Load: 4 tons; Armament: 9 machine guns

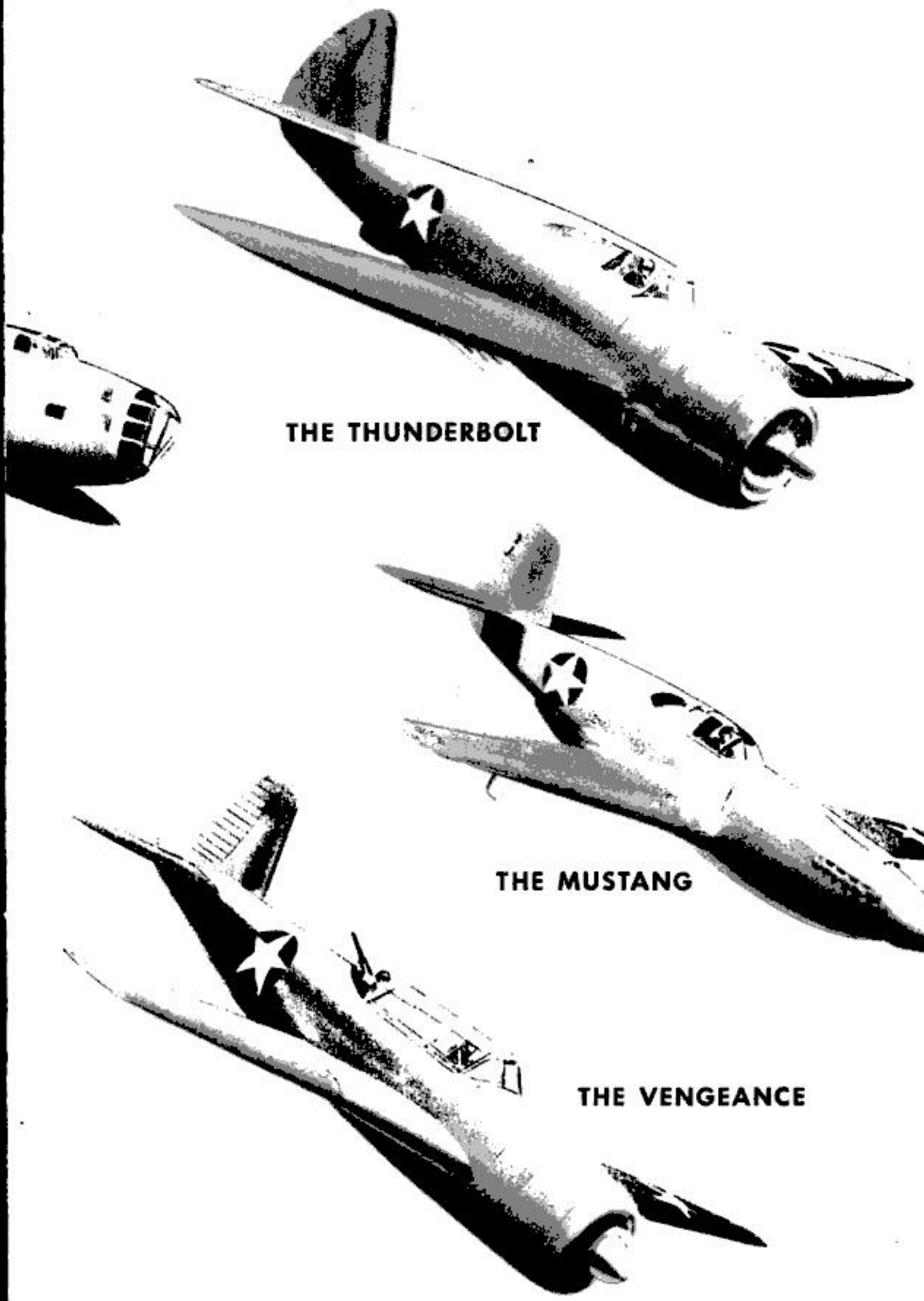


A-20
DOUGLAS BOSTON, HAVOC

Power Plant: 2 1,250-hp. Wright Cyclones; Span: 61'4"; Length: 47'; Height: 15'10"; Weight: 15,-030 lb.; Speed: 300 class; Armament: Varied

P-40
CURTISS WARHAWK

Power Plant: 1,200-hp. Packard Rolls-Royce Merlin; Span: 37'4"; Length: 31'8"; Height: 10'7"; Weight: 7,100 lb.; Speed: 373 m.p.h. (app.); Ceiling: 30,000 ft.; Armament: 6 .50 cal. machine guns



THE THUNDERBOLT

THE MUSTANG

THE VENGEANCE

WINGS OF VICTORY. On these 11 basic types of combat aircraft the U. S. Army rests its assurance of triumph in the war in the air. Every one of these planes is the result of a long process of design and development. In the acid test of combat on many fronts, they have given a good account of themselves against the best comparable planes of the Axis Powers. Further experience may modify design, but this is the pattern. Today and always, Americans may be confident that our planes are worthy of the skill and courage of our flyers. *POPULAR SCIENCE MONTHLY*

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THE LIBERATOR
THE LIGHTNING
THE AIRACOBRA
THE WAR HAWK
THE HAVOC

THE FLYING FORTRESS

THE MITCHELL

THE MARAUDER

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H THE JAP MITSUBISHI

LIGHT STRUCTURE, THIN SKIN WHICH CAN'T TAKE IT

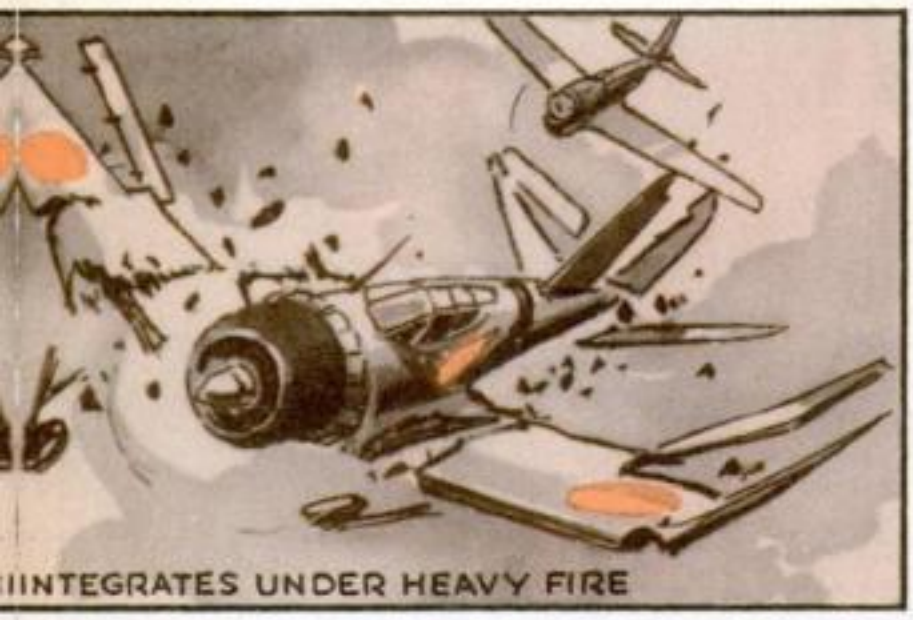
HARD TO FLY

NO ROOM FOR PARACHUTE. PILOT DIES WHEN PLANE IS DOWNED

NO SELF-SEALING GAS TANK

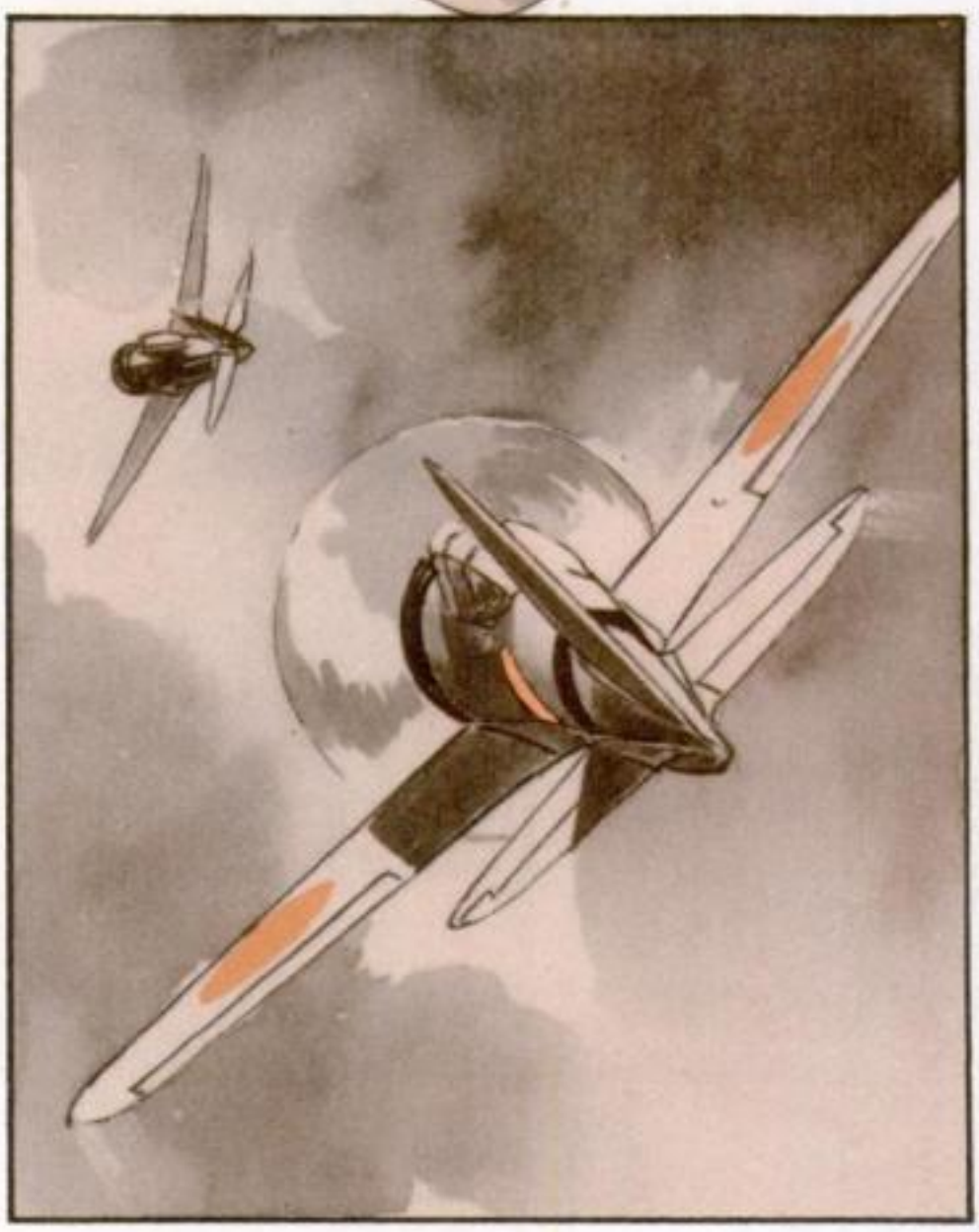
AIR-COOLED, DOUBLE-BANKED RADIAL MOTOR. 14-CYLINDER. LOW HORSEPOWER

LIGHT INEFFICIENT ARMAMENT



IINTEGRATES UNDER HEAVY FIRE

BOTH PLANE AND PILOT ARE LOST WHEN HIT



WORTHLESS EXCEPT FOR ATTACKING OTHER FIGHTERS

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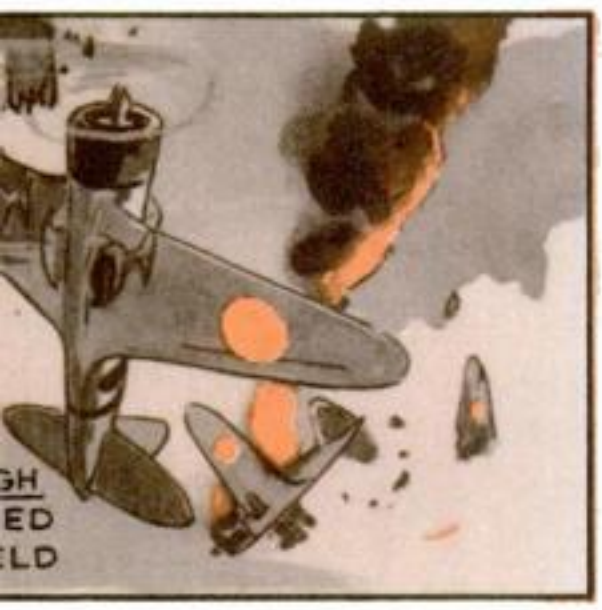
HOW THE BEST-KNOWN U. S. FIGHTER LINES UP WITH

N-LINE LIQUID-COOLED
MOTOR. PLENTY OF
HORSEPOWER

VERY FRONT



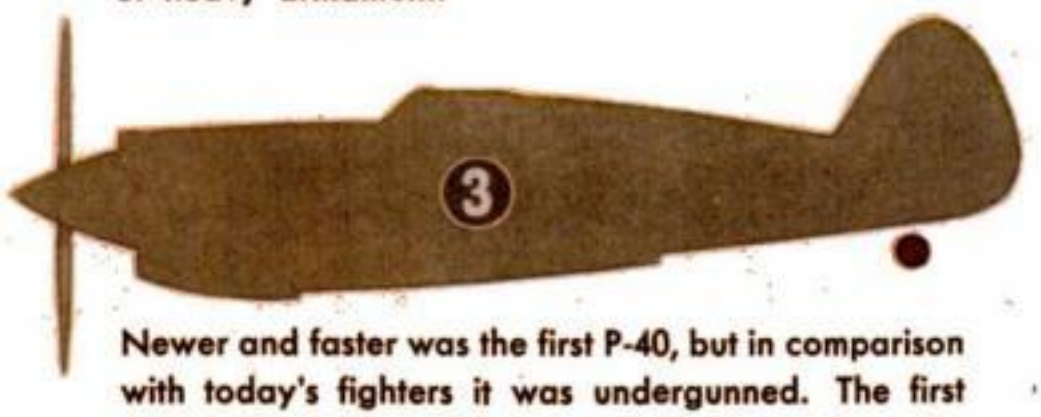
NK 30,000 TONS OF JAPANESE
LS

EVOLUTION OF A GREAT FIGHTER

The Warhawk (P-40F), like the British Spitfire, has been improved from year to year. Below are stages in its evolution from a low-speed, unarmored, low-firepowered job into a tough, highly protected slugger of the skies.

As the Hawk (P-36) it had a radial engine. Manned by French pilots it outfought Messerschmitts early in the war.

As the P-37 it grew longer and was powered by an in-line, liquid-cooled engine. It still lacked the punch of heavy armament.



Newer and faster was the first P-40, but in comparison with today's fighters it was undergunned. The first P-40 had neither armor nor self-sealing gasoline tanks.

Today's Warhawk is the seventh of the P-40 series, and a lot of experience has been built into it. Armor, fire power, and punch — all are there.

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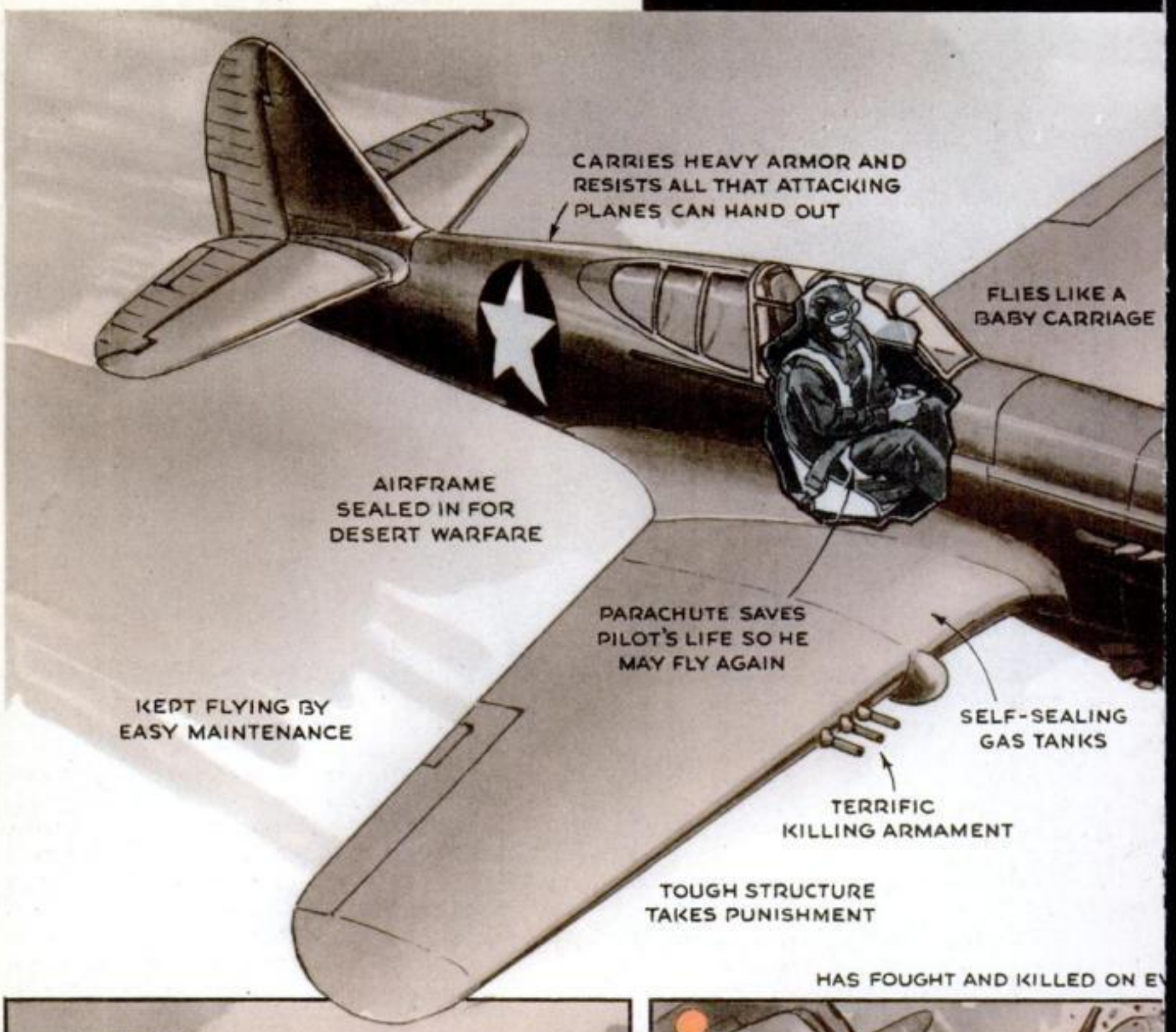
P-40 VERSUS ZERO:



HAS FOUGHT AND KILLED ON EV

USED AS FIGHTER, FIGHTER-BOMBER, TANK KILLER, AND FOR GROUND CO-OPERATION

AS BOMBERS, SIX SALVAGED P-40'S SA
COMBAT VESSE

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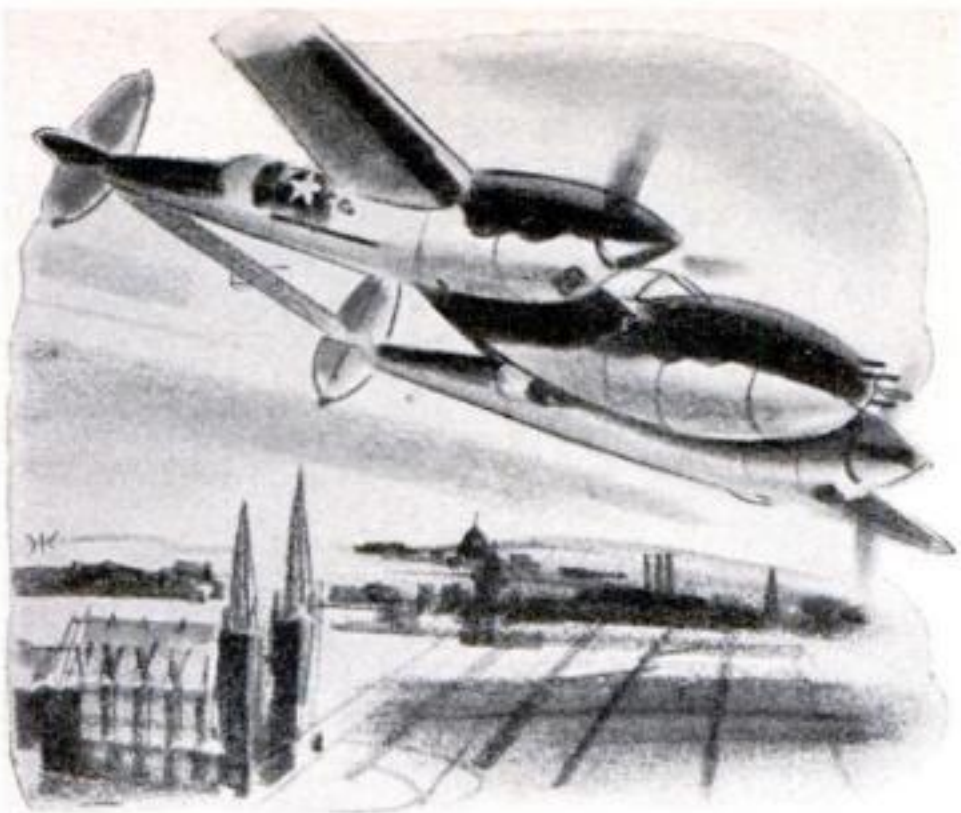


The P-38's speed, range, and climb qualify it as a hot escort fighter. Teamed up with the British Stirlings and Lancasters, it has chalked up notable victories at Cologne, Bremen, and other raided industrial cities

and other models that carried the brunt of the early blitz were short-range aircraft. Their mechanical advantages had to be pared considerably to get them over England and the thousands of wrecked aircraft that littered the English countryside were evidence of the stupidity of the move. Goering had, in the homely words of the late "Paddy" Finucane, "tried to eat soup with a knife."

How good have *our* guesses been? How well are we prepared to fight the type of war that is unfolding, with equipment that had to be planned two or more years ago?

Ten or possibly 11 United States types now in production will carry the weight of our part in the current conflict.

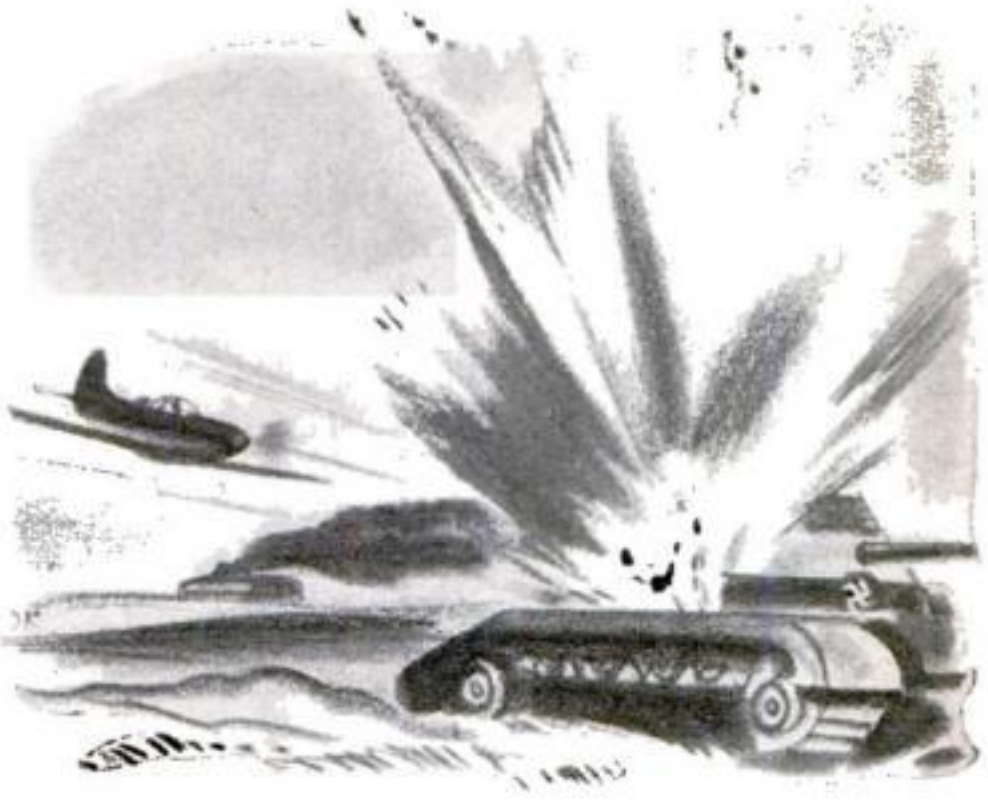
Probably the most discussed and maligned of our types has been the Curtiss P-40. This ship has, at times, been called the worst and the best guess of the entire war. Its design was laid down when no one knew quite what the war was going to turn out to be. The type has undergone seven alterations and modifications, each one a distinct improvement. It evolved as the work horse among United Nations single-seaters.

Tactically, it is an advance-guard airplane. It is assigned to new operations where all-around performance is needed plus the ability to "take it." P-40's have been active in every United Nations front in this war where land-based aircraft have operated. They are selected because they are tough and can be thrown against anything the enemy has. Even if they are outperformed, they are "beefy" enough structurally to "duck for home," bringing with them what special information is necessary to dictate the specialized aircraft or action needed to replace them. They are easy to maintain. Simple, rugged design and structure have produced an airplane that is easy to service and repair. Major structural replacements, needed only when the ship is badly battered, can be accomplished with the most elementary tools. The airframe requires virtually no attention. It is sealed and bonded against the ravages of sand, snow, and tropical rain. They can be staked outdoors for months on end. A mechanic who serviced the type in the Philippines, where airplanes are known to disintegrate outdoors, said that all the P-40 needed was gas, oil, and a few kind words and it would keep running forever.

Justification for the type need only be read in the final box score wherever the P-40 went. In the Philippines, a handful of them cost Japan over five ships for each P-40 in combat. Here they acted as fighters, scouts, photo ships, and even bombers. During the last days on Bataan, MacArthur's mechanics stuck four P-40s together out of wrecks and spare parts, rigged them as bombers, and sent them out to sink 30,000 tons of shipping in Subic Bay.

In China, their score was 3.9 to one, in Australia, 3.1. In Russia they were the only craft capable of clearing the way for the Stormoviks, while in the Libyan desert they tackled tanks and bombed troop emplacements. Wherever the task assigned to it paralleled the original purpose of the fighter, the U. S. defense problem, it made every-

With the 37-mm. gun in its nose and its remarkable maneuverability even at high speeds, the P-39 has turned out to be a tank killer rivaling Russia's celebrated Stormovik. It's strange work for a mid-altitude fighter



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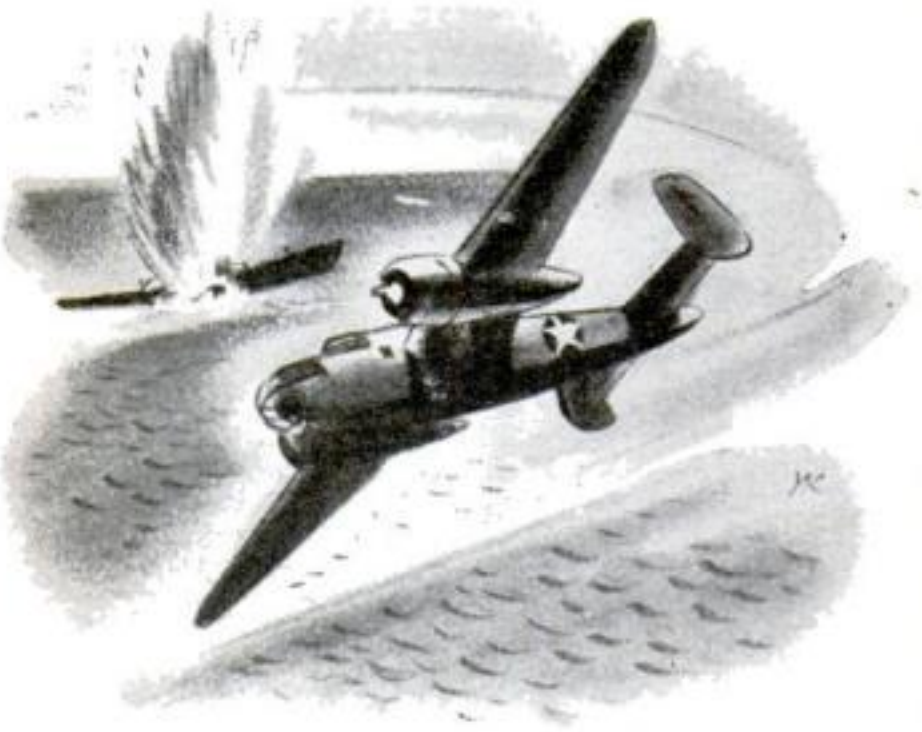
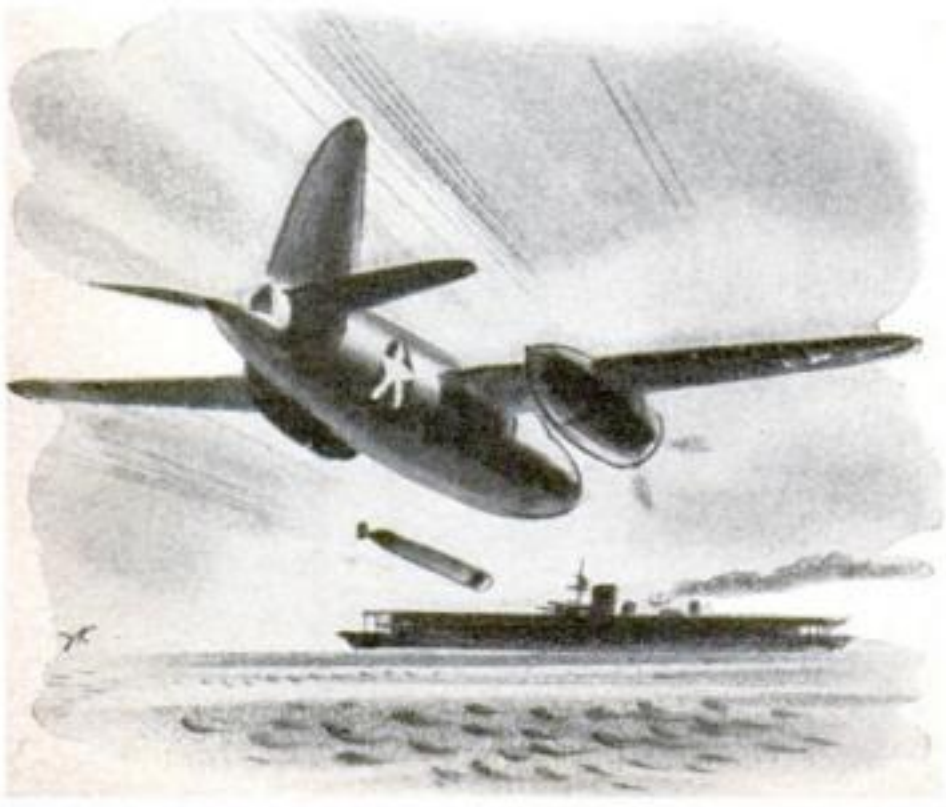
The Mitchell (North American B-25) Has Made History in This War

IT BOMBED TOKIO



FIRST U-BOAT SUNK IN THE ATLANTIC

The Marauder (Martin B-26) Used Torpedoes at Midway



thing else it encountered look ridiculous. The war in the desert belonged to U. S. types, for at those distances and under those conditions they were at home.

Probably the prize dumb comparison in this war is that of the former naval pilot who compared the P-40 with the Jap Zero. The over-all box score should have told the story—3.52 Japanese lost for every P-40. In turn and rate of climb, certainly the Zero had an ample edge, but it paid plenty for the privilege. To begin with, the Zero weighs 4,750 pounds wringing wet. It carries neither armor nor a self-sealing tank. Its fuselage, from the cockpit back, is covered in a gauge of dural thinner than any rolled in the U. S. It had only a fraction of the number of instruments carried by the U. S. pilots, the flier wore no parachute, the general structural factor of safety was about 2.5 to 1, differing from the 12-to-1 characteristic of our craft. Annodizing, to protect the ships from ravages of the weather, is virtually unknown. The Zeros are frequently unpainted and only a "dimmer" coat keeps the sun from making them a long-range target.

Those who would like our men to fly this kind of a winged coffin are reminded of one thing. At the outset of the war, a rumor was current that the "heroic" Jap pilots would crash-dive their airplanes rather than allow them to be captured in examinable shape. This was a figment of the imagination. The truth of the matter was that the Zero was so frail, that any mishap in landing would practically roll the craft up into a ball.

The Curtiss-Wright Corporation finally sank the "magnificent Zero" myth once and for all when they stripped thirteen hundred pounds of weight out of a P-40—spare guns, self-sealing tanks, instruments and the like. They reduced its armament and load to that of the Zero without impairing the P-40's inherent structural strength. The experimental airplane, thus stripped, carrying a 180-pound pilot with his parachute—and, toting a wing loading in excess of the Zero's 20 pound per square foot, outclimbed, outturned, outmaneuvered and outfought the Zero on every one of the 11 basic categories of performance laid down by General Chennault and the Flying Tigers in China.

The question arises, why are these airplanes fought carrying these heavy wing loads? The answer can be found in the basic military philosophies of the two nations. To the Japanese, the victory belongs to some abstract personage and the soldier. His individual existence means nothing. Providing for a better than even chance for the pilot is unheard of. Techni-

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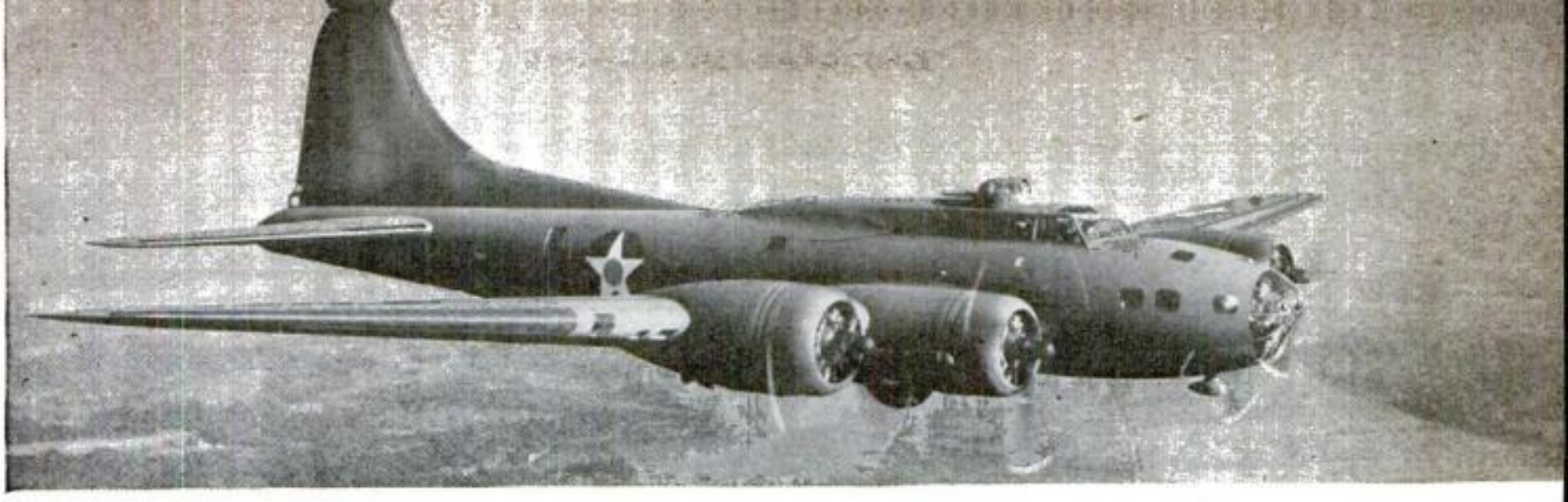
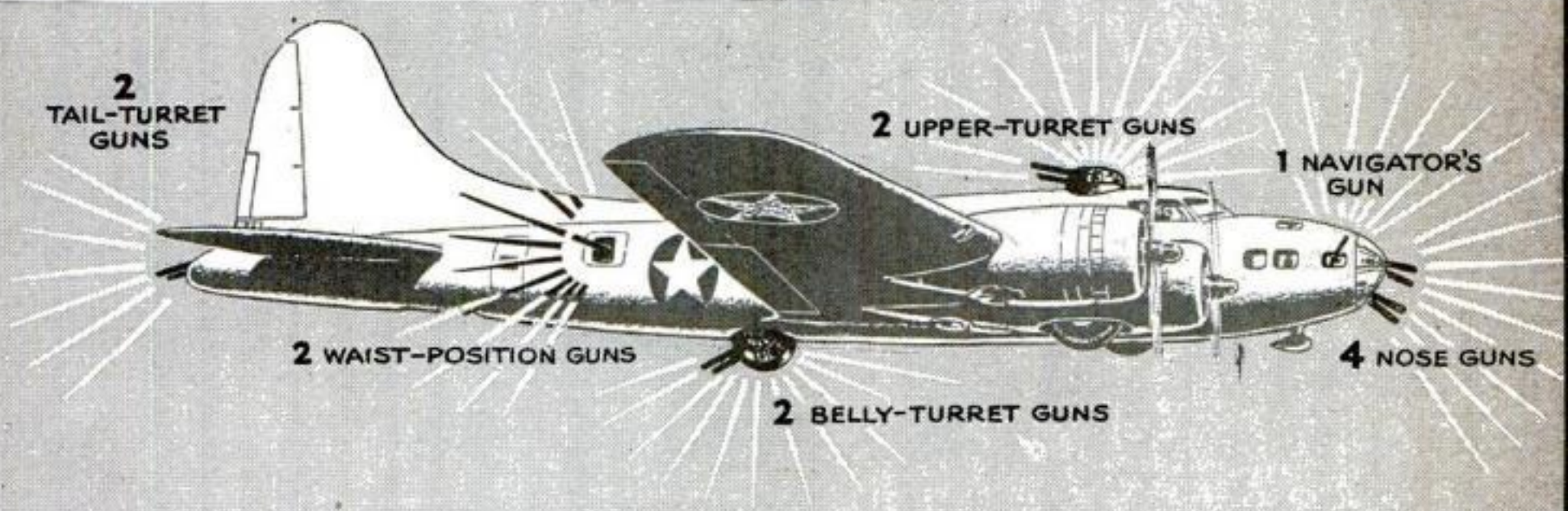
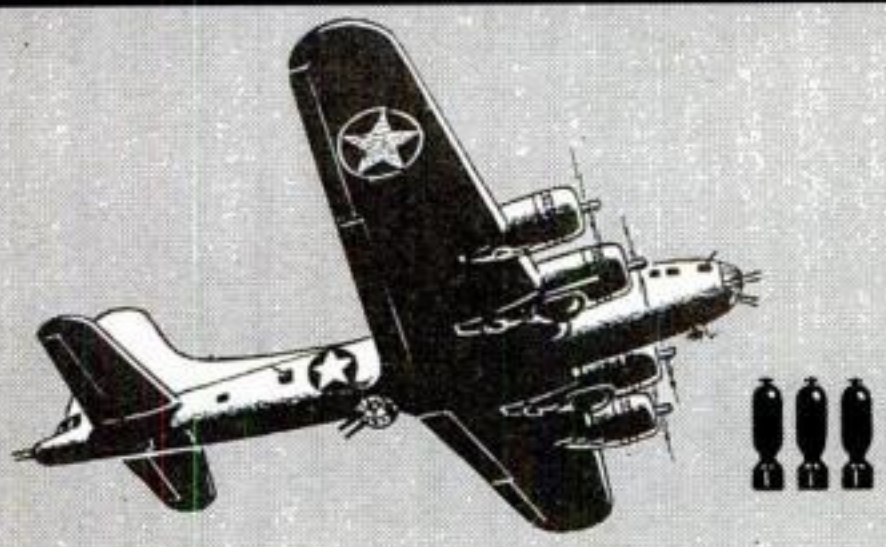


THE SELF-SUFFICIENT FORTRESS NEEDS NO FIGHTER ESCORT



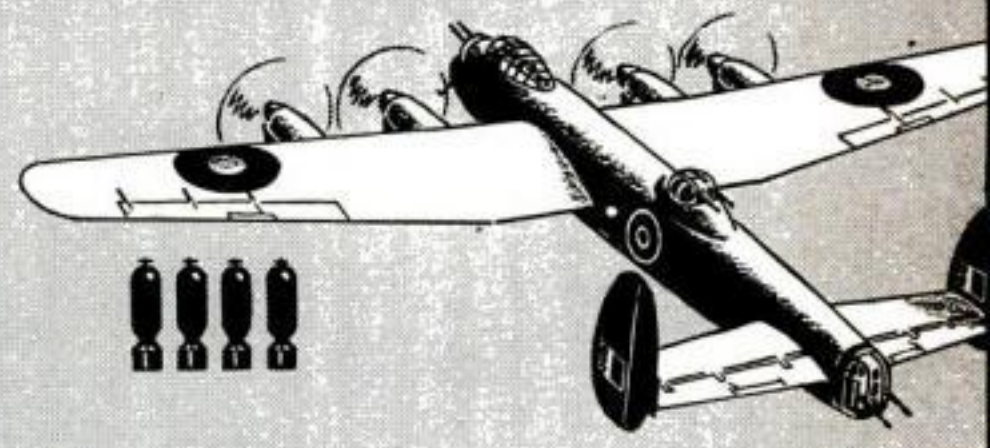
A bomber is said to be self-sufficient when it is able to complete the mission for which it was designed without support of other aircraft. This means that it must have armament to protect it in every quarter from any possible attack. Bombers that have "blind spots," or are inadequately gunned, must be escorted by fighters and their bombing range is limited to the range of such craft. The drawing shows the Fortress' bristling armament

THE TRUTH ABOUT THE FLYING FORTRESS AND THE LANCASTER



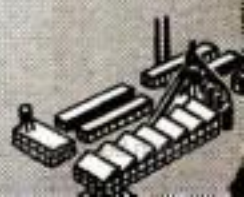
BOMB LOAD of the Fortress has been compared unfavorably with that of the British Lancaster. Such comparisons are misleading because the two planes are designed for different missions. The B-17 carries 3½ tons of bombs, plus ammunition

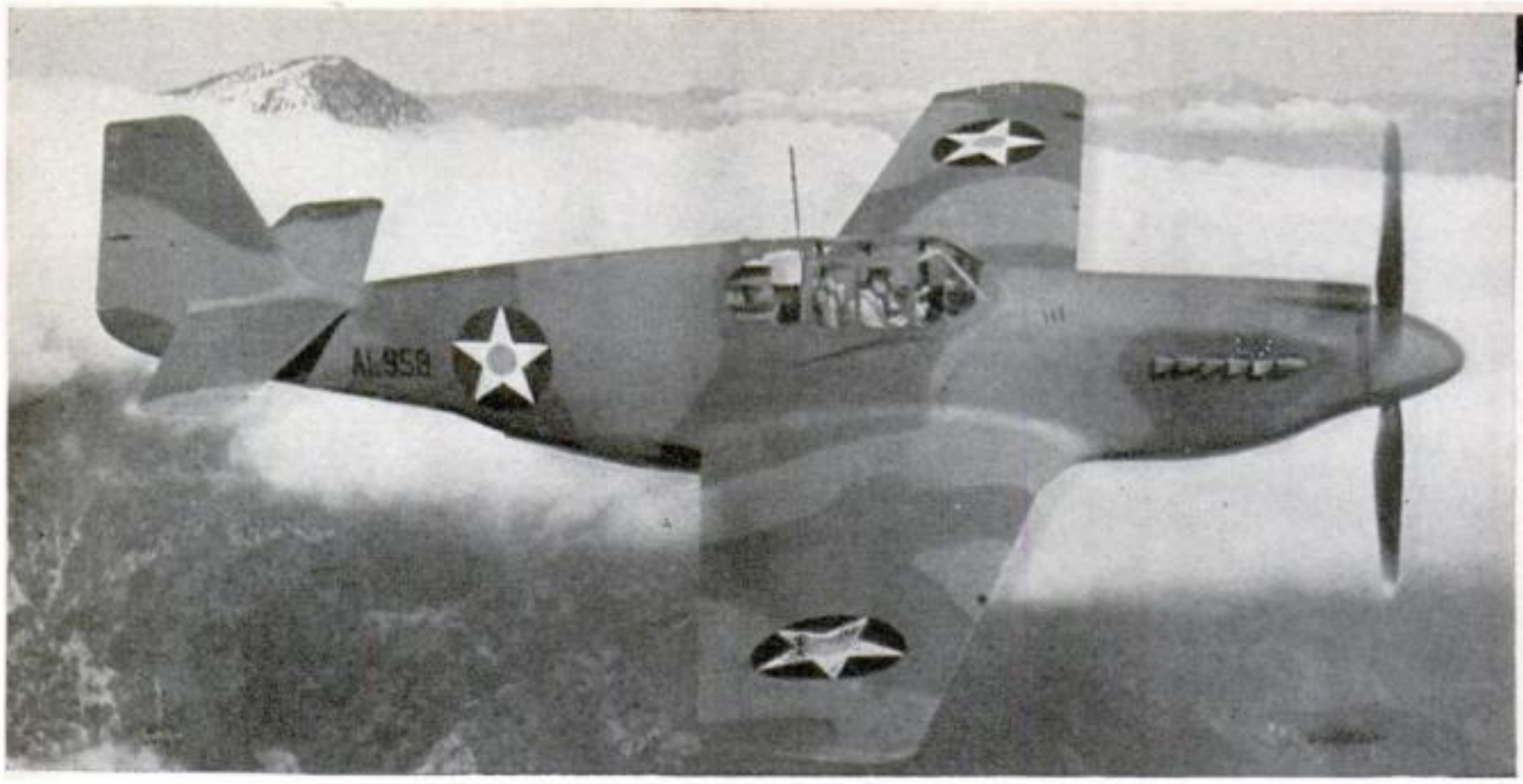
RANGE. With this load, the Fortress can fly to a target more than 1,000 miles away, drop its bombs, and return. For shorter trips, more bombs can be taken. At the same time, the B-17's defensive armament is not sacrificed



BOMB LOAD. The world's greatest load lifter in the production-bomber class, the Lancaster does carry more bombs in its long, cavernous bomb bay. But it is intended for a different job—pattern bombing of industrial and military areas at night, with an escort

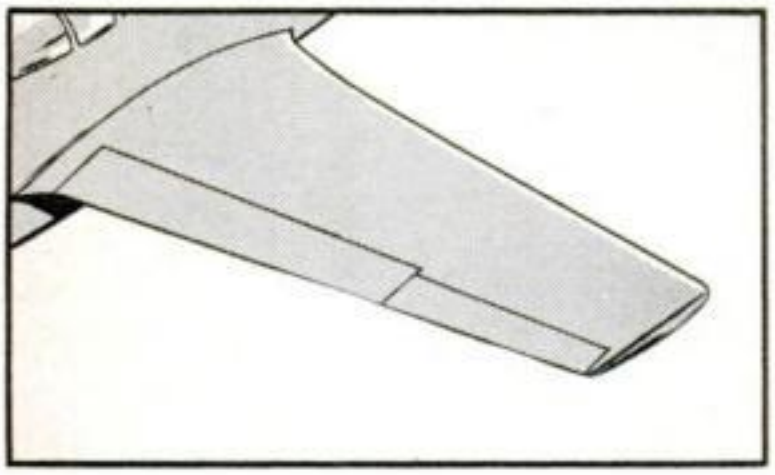
RANGE. Lancaster's average mission is to bomb a target about 750 miles away, flying at medium altitude. Since it must be protected by fighters, it cannot go farther than these relatively short-range craft. Load saved goes into bombs



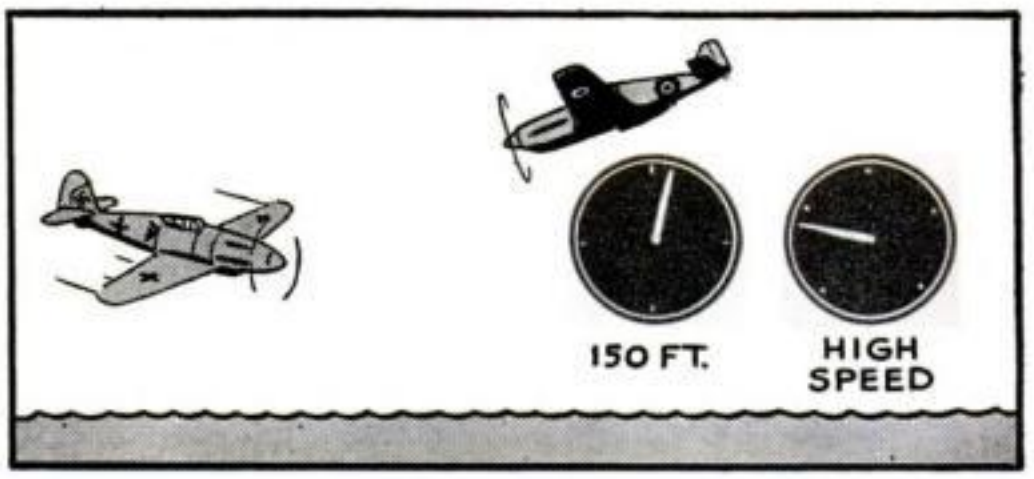


"Change of pace"—making the enemy meet a new type of weapon—is the strategy behind the P-51 (Mustang). Developed at the request of the British Air Ministry, it is designed to perform well at low altitudes. It is not expected to meet high-altitude fighters on their own grounds; they must come down

THE BRITISH SCRAPPED THEIR OWN PLANE FOR THIS U.S. TYPE



WING DESIGN is the secret of the Mustang's low-level performance. A new contour prevents turbulence from developing in the denser air



AS A SEA-LEVEL FIGHTER, the Mustang has a big advantage over altitude fighters like the German FW-190, as the Nazis discovered when they tried to meet the P-51

cal experts who have examined the wreckage of the Zero state that its frailty made simply flying this craft an act of desperate heroism. Extreme gust acceleration found under thunderheads or similar meteorological conditions have been known to shake the Zero apart. We as a nation believe that the victory belongs to the individuals who make up the nation, the air crews among them. The victory is of little value to them if they do not survive to enjoy it. We choose to enhance our pilots' chance of survival by every mechanical means at our disposal, leaving heroism to the individual choice. We simply do not elect to pay for that kind of performance with the safety of our flight crews.

The ultimate justification for our philosophy of sacrificing the edge of performance for a margin of safety lies in the fact that Japanese Sentoki 001, the successor to the Zero, carries self-sealing tanks, heavier general structure, etc. Despite 300 more horsepower, it is inferior to the original Zero on climb and turn. While human life is a small consideration to the Japanese high command, the number of men lost through structural weakness of the craft prompted a change. The Jap Air Staff guessed wrong—the change admits it.

The next in line for literary back-stabbing is the P-39, the Bell Airacobra. From its inception, this child of scorn and wizardry had a lot of people disliking it. The pilot sat in front of the engine, the power was delivered in a U line down from the drive shaft, under the cockpit floor, and up to the propeller. Here it met the basic assumption of the Airacobra, the 37-mm. cannon, supported by two synchronized .50 caliber guns and four .30's firing free outside the propeller arc. Changes may have

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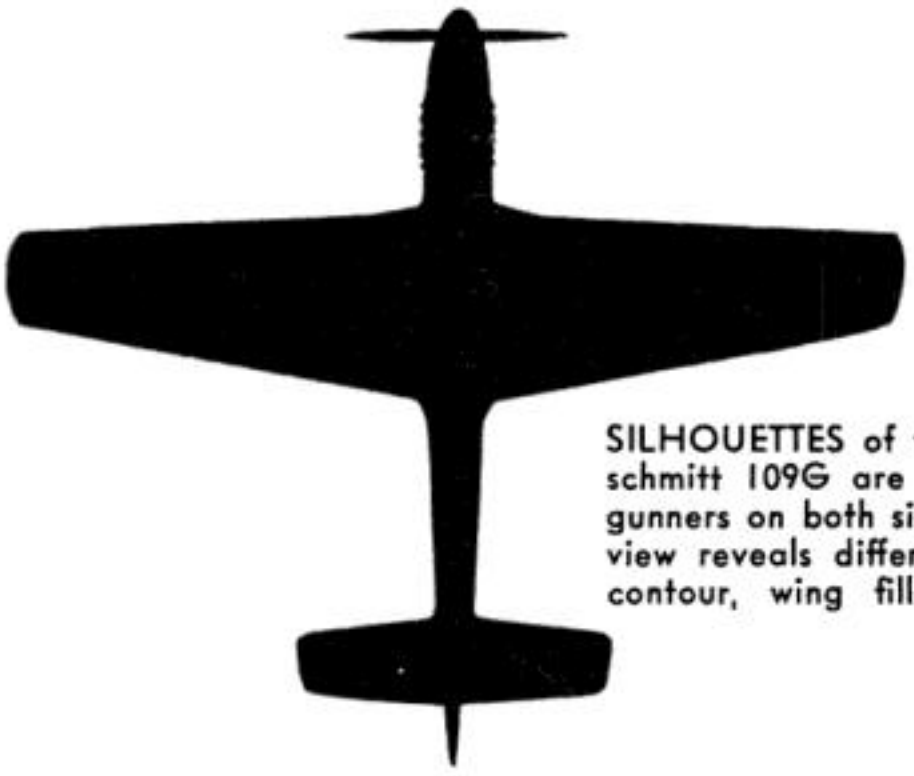
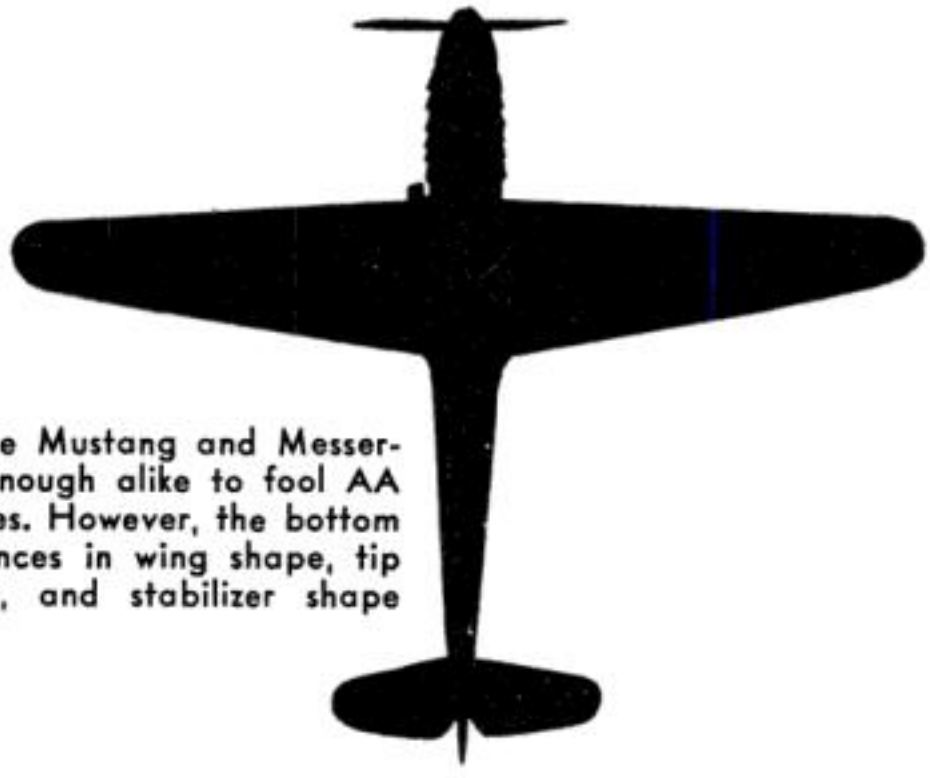
THE P-51—FIRST U. S. PLANE BUILT FROM WAR INFORMATION



THE MUSTANG

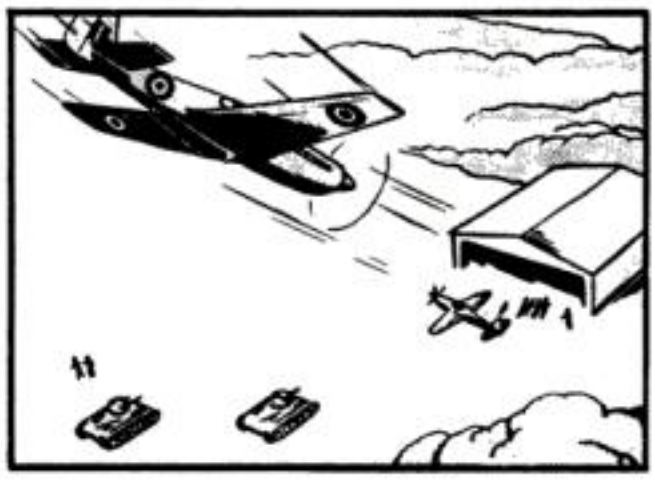
SILHOUETTES of the Mustang and Messerschmitt 109G are enough alike to fool AA gunners on both sides. However, the bottom view reveals differences in wing shape, tip contour, wing fillet, and stabilizer shape



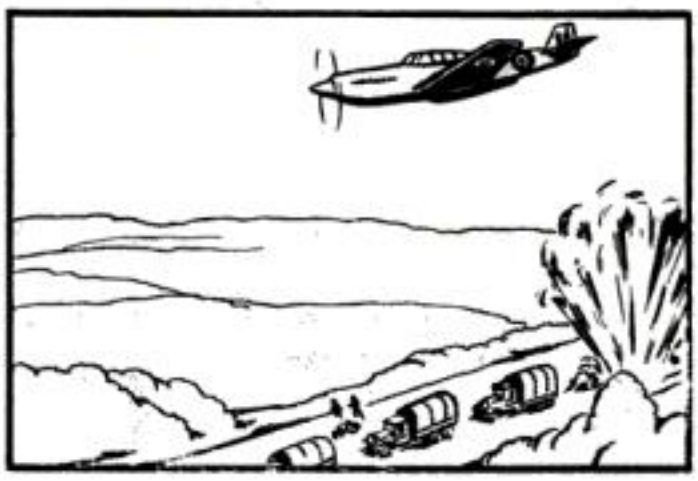
THE MESSERSCHMITT

HERE ARE SOME OF THE JOBS OF THE LOW-FLYING MUSTANG

PHOTOGRAPHY. The Mustang can sneak in and out for pictures



ATTACKING GROUND TROOPS is made easy by its perfect handling at ground level. Armament is plentiful



BOMBING. Use of various types of bombs permits the Mustang to take over the work of other fighter-bombers

been made in the general armament setup, but the theory of building an airplane behind a gun had proved out. The Airacobra is murder on anything that gets in front of it.

The radical idea of putting the engine, the heaviest single piece of equipment in the whole airplane, smack on the center of lift and load was looked at with suspicion by orthodox designers and air tacticians. Off-line power delivery looked uncertain, unreliable, and an invitation to maintenance trouble. Nevertheless, the guess was that somewhere an airplane would be needed that could blast its way into and out of formations of anything that flies. Larry Bell started with the idea that the best place to put an antiaircraft gun was on an airplane. The most important single advantage of the P-39 general design is that the size, rate of fire or shell velocity of the forward-firing gun can be altered as the requirements of war change, without major modification of the type.

The P-38 was our original bid for high-altitude strength. A radical design, it is singularly maneuverable for a twin-engined ship. The basic disadvantage of most twin-engined fighters is their inability to make short-radius turns. Having two parallel lines of thrust and two similar torque allowances to make, the craft must "bend" two force lines in order to turn. This makes the banking harder, just as it is more difficult to turn sharply with a car than it is with a motorcycle. The Lightning gets away from this problem in a measure by turning the propellers in opposite directions. Thus each engine counters the other's torque, eliminating dynamic allowances for this turning tendency such as wing warping, and offsetting the *(Continued on page 222)*

HOW DEADLY IS ARIZONA'S PUBLIC ENEMY NO. 1?

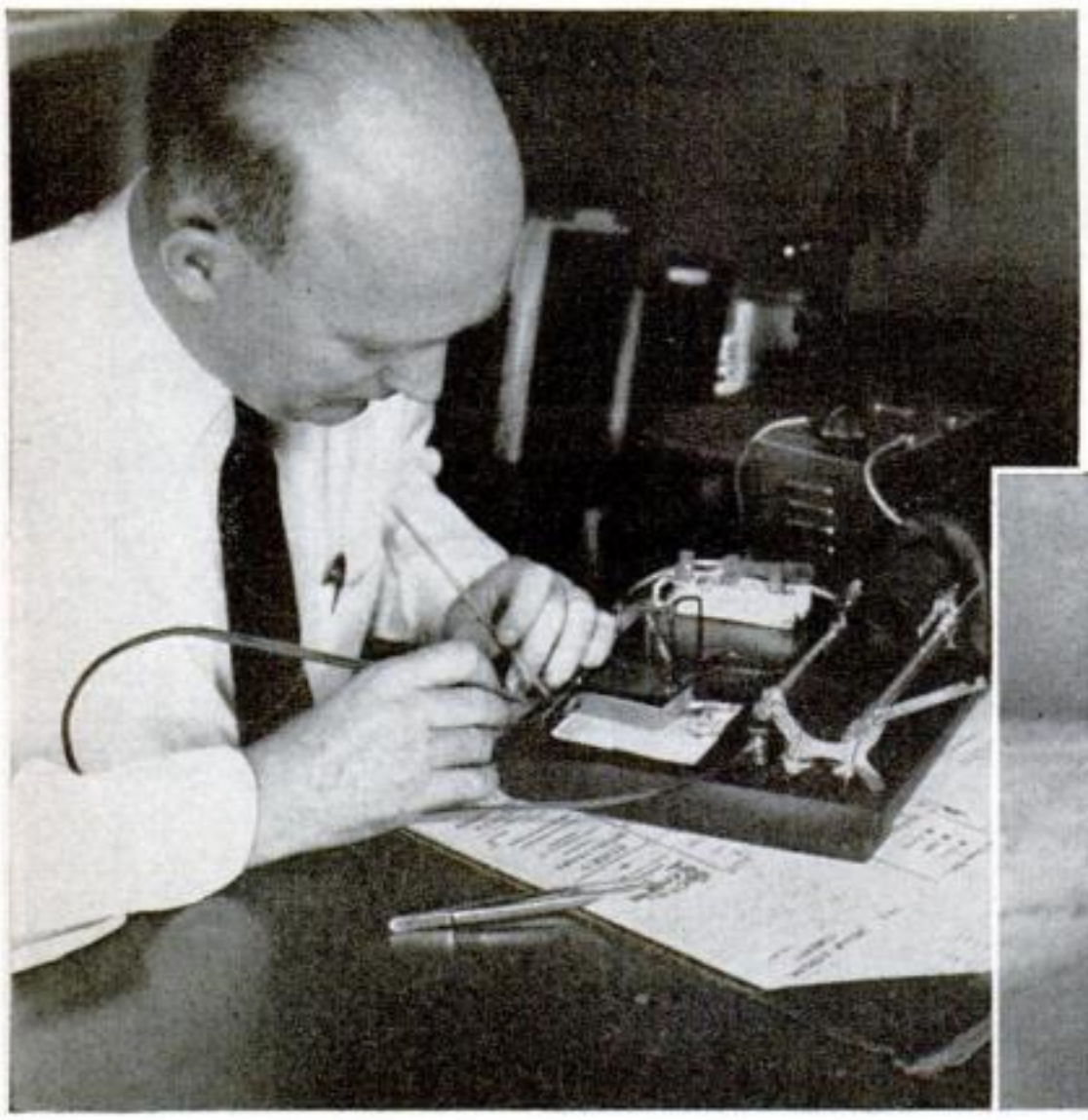
BY HERBERT L. STAHNKE

OF THE 40-odd species of scorpions found in the United States, two are dangerously virulent to man; their venom can, and frequently does, cause death. As far as is known, the lethal varieties of these eight-legged little monsters, which are not insects, are confined to Arizona, principally the southern half of the state, although recent reports indicate that a few, or perhaps a new species, live in Texas and California. The comparatively harmless species, common examples of which are the striped-tail scorpion *(Vejovis spinigerus* Wood) and the giant hairy scorpion *(Hadrurus hirsutus* Wood), are fairly abundant in all of the western and southwestern states. They are only mildly poisonous, about as much so as a wasp or a bee. Their sting produces a local swelling, often painful and accompanied by discoloration. In some cases the pain is more severe than in others, and occasionally may travel a short distance from the site of the sting. But under normal conditions there is no danger of death.

To be stung by the *Centruroides sculpturatus* Ewing or the *Centruroides gertschi* Stahnke, however, is another matter. The venom of both *sculpturatus* and *gertschi* is a neurotoxin, that is, it affects the nerves, and unless proper treatment is applied at once the victim may die in heavy convulsions after from 45 minutes to four or more hours of intense pain. Experimental animals, such as white rats, have been known to die in 10 minutes after being stung.

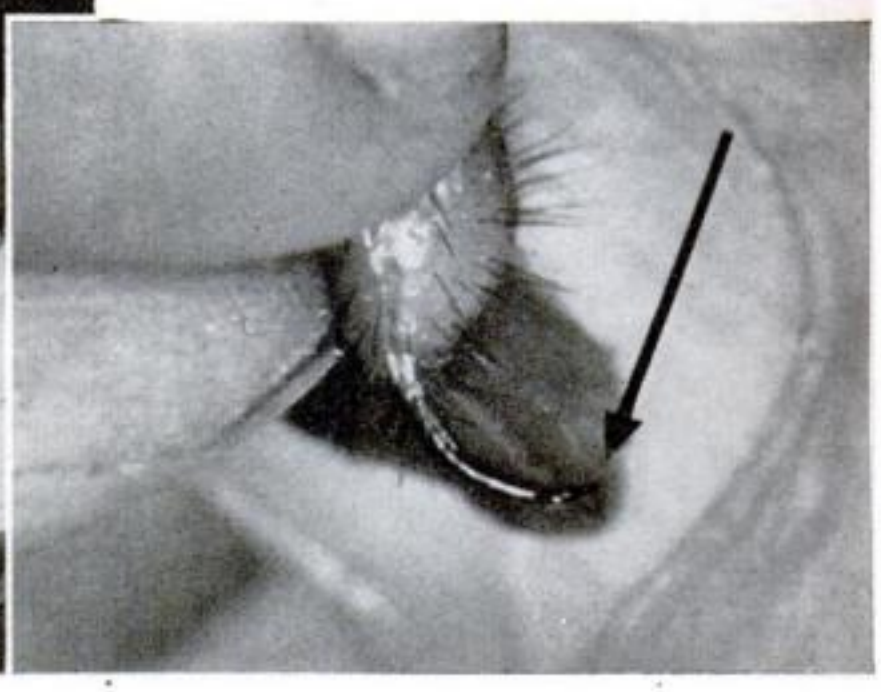
Both *sculpturatus* and *gertschi* are slender and innocuous-looking creatures, and are small; a specimen measuring 2½ inches from the tip of its head to the tip of its tail is considered large. In general they are of a solid, yellowish straw color, but *gertschi* can be distinguished by two irregular black stripes down its entire back. The poison glands are located in the last segment of the tail, the hard outer covering of which is

The author, Herbert L. Stahnke, Ph.D., is associate professor of science at Arizona State College, Tempe, Ariz.



At left, a scorpion is being "milked" by electrical induction. Pure venom obtained by this method is injected into experimental animals for tests

A drop of the deadly stuff is seen below at the tip of the stinger, a fine, hollow needle located at the end of the last segment of the tail



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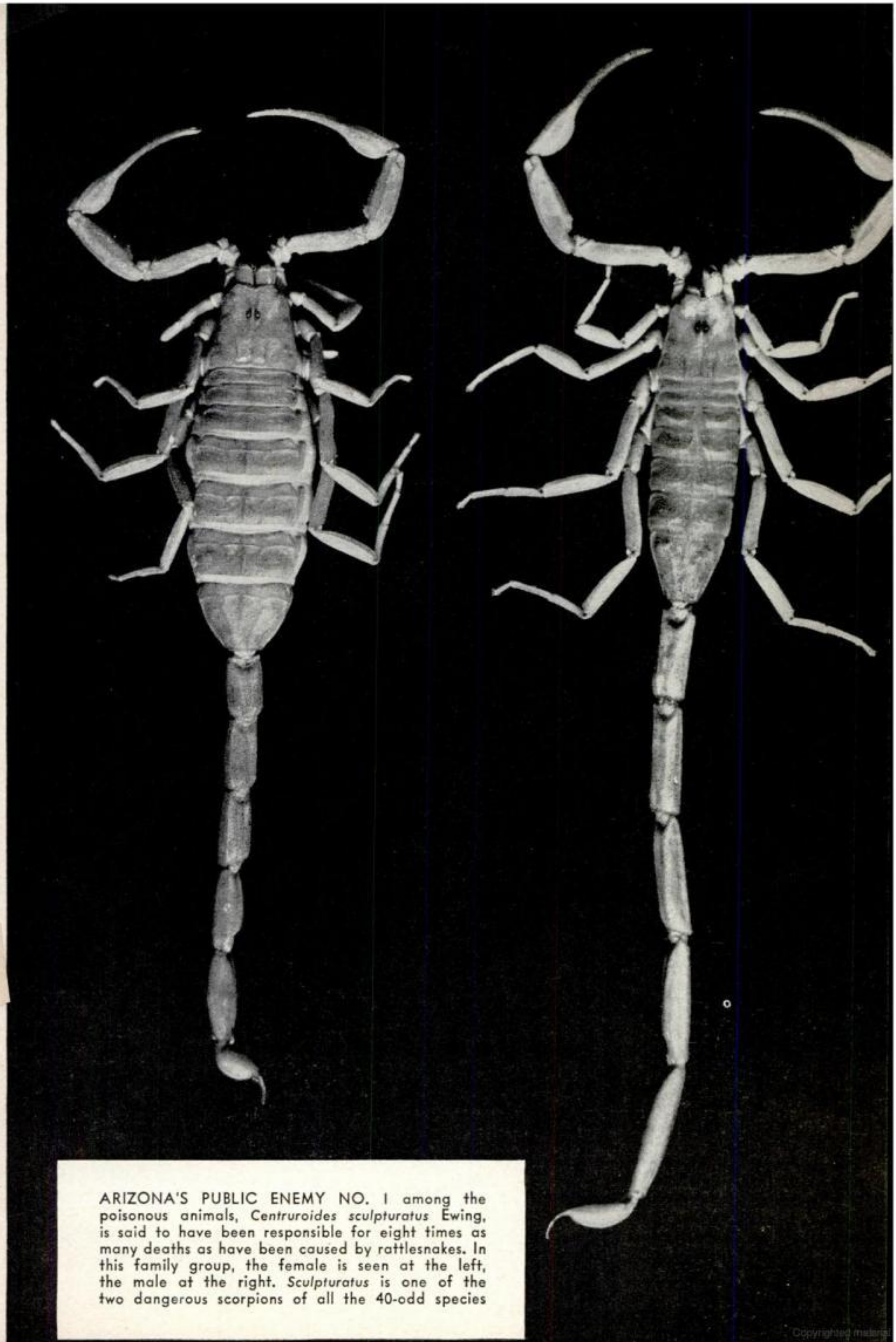

ARIZONA'S PUBLIC ENEMY NO. 1 among the poisonous animals, *Centruroides sculpturatus* Ewing, is said to have been responsible for eight times as many deaths as have been caused by rattlesnakes. In this family group, the female is seen at the left, the male at the right. *Sculpturatus* is one of the two dangerous scorpions of all the 40-odd species

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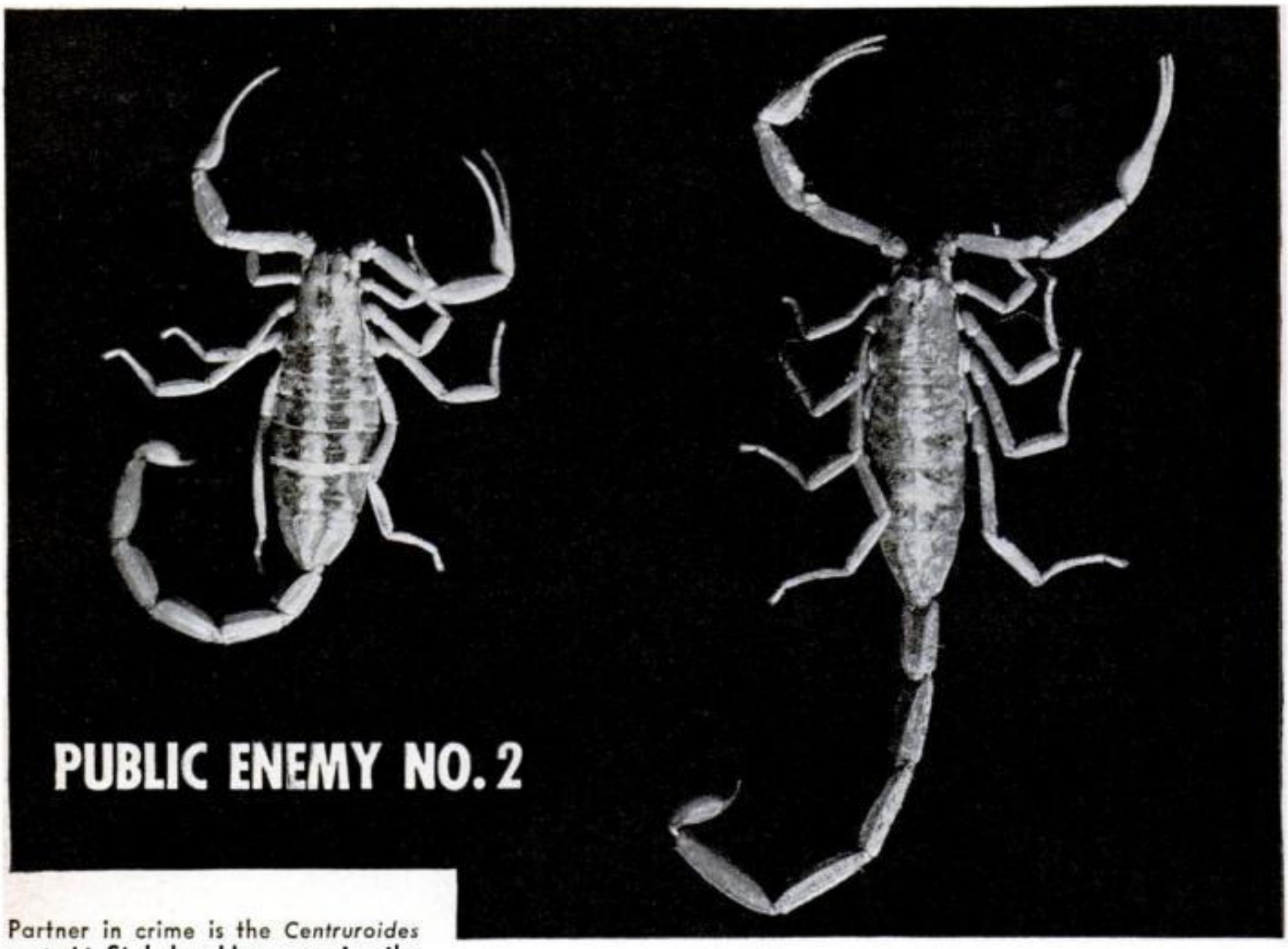
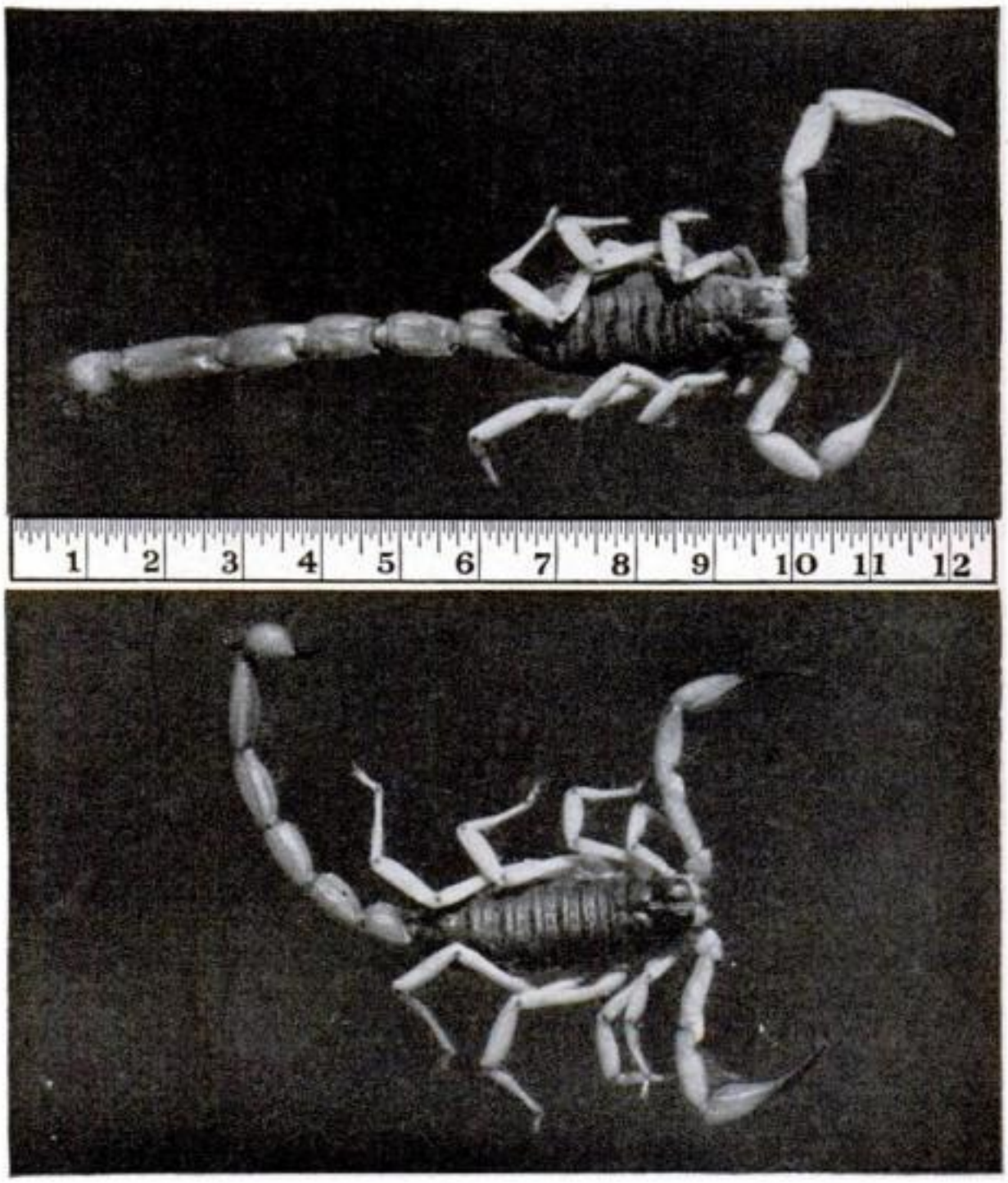


PUBLIC ENEMY NO. 2

Partner in crime is the *Centruroides gertschi* Stahnke. Here, again, the female is shown at the left. Like *sculpturatus,* it is of a solid, yellowish straw color, but may be distinguished by two irregular black stripes down the back. Both of the deadly species are small: a specimen measuring 2½ inches from tip of head to tip of tail is a big one

Much more formidable-looking, but relatively harmless, is the light-faced giant hairy scorpion *Hadrurus hirsutus* Wood seen at direct right. As shown by the metric scale, this specimen is about four inches long. The author has a specimen measuring 124.4 millimeters (nearly five inches) from end of head to tip of aculeus, or stinger. In spite of its appearance, the sting of this hairy monster is less harmful than a wasp's

A close relative of *hirsutus,* and also comparatively innocent, is the blackish giant hairy scorpion *Hadrurus spadix* Stahnke. Fortunately, most of the scorpions found in the western and southwestern states are not deadly. The venom of *spadix,* for example, causes a rather painful local swelling but will not result in death even when injected into a six-weeks-old rat. The lethal *sculpturatus* and *gertshi* are principally confined to southern part of Arizona



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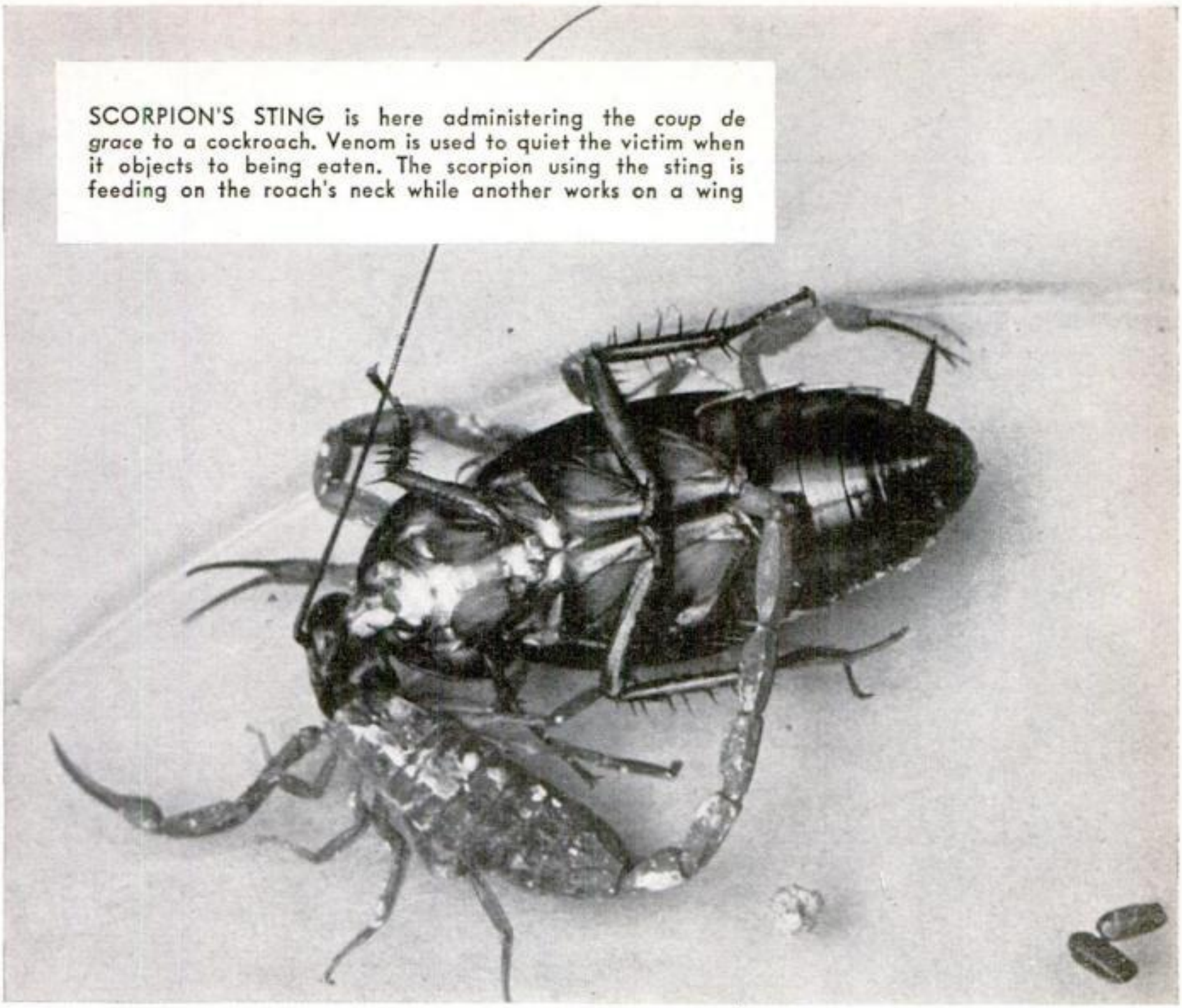

SCORPION'S STING is here administering the *coup de grace* to a cockroach. Venom is used to quiet the victim when it objects to being eaten. The scorpion using the sting is feeding on the roach's neck while another works on a wing

prolonged into a fine, hollow, needle-sharp, permanent stinger which punctures the victim's body. The venom, to an amount roughly equal in volume to one fifth the size of a common pin, is injected into the wound through the hollow stinger.

Neither of these dangerous species, nor any of the mildly poisonous scorpions, will ever attack a human being, but they will sting quickly in self-defense if they are disturbed. Since all scorpions, and especially *sculpturatus,* are often found in human habitations, any one living in scorpion country should always be on the alert. And when picking up boards, stones, and other objects out-of-doors, the fingers should never be placed on the under side. Scorpions frequently cling to these surfaces, and if the fingers happen to press them they will sting. If a person feels a scorpion, or for that matter any insect or other crawling animal, on his body, he should brush it off instead of dispatching it with a vengeful swat.

The most effective first-aid treatment for scorpion sting, especially the sting of the dangerous species, consists simply of ice therapy. The ice has no effect on the venom itself, but decreases absorption and localizes the poison. This treatment should be begun immediately in order to obtain best results.

In an instance where the victim has been stung on the finger tip, the most effective way of treating the sting is to immerse the hand in a mixture of finely crushed ice and water. The hand should be kept in the solution until the action of the venom can no longer be felt and the solution feels painfully cold. Then the hand should be removed for a few seconds, and then immersed in the solution again. The practice of alternately immersing the hand and withdrawing it from the solution should be kept up for from two to three hours, and if it is done intelligently and faithfully no other treatment is likely to be necessary. What actually happens in this treatment is that the removal of the hand from the ice solution permits a small quantity of the venom to enter the body, where it is successfully combatted by the body's protective agencies. Ice packs may be used on parts of the body where immersion is not practicable, but if the sting is on the face, the back of the neck, or the backbone, no time should be lost in getting the patient to a hospital or a physician experienced in treating scorpionism.

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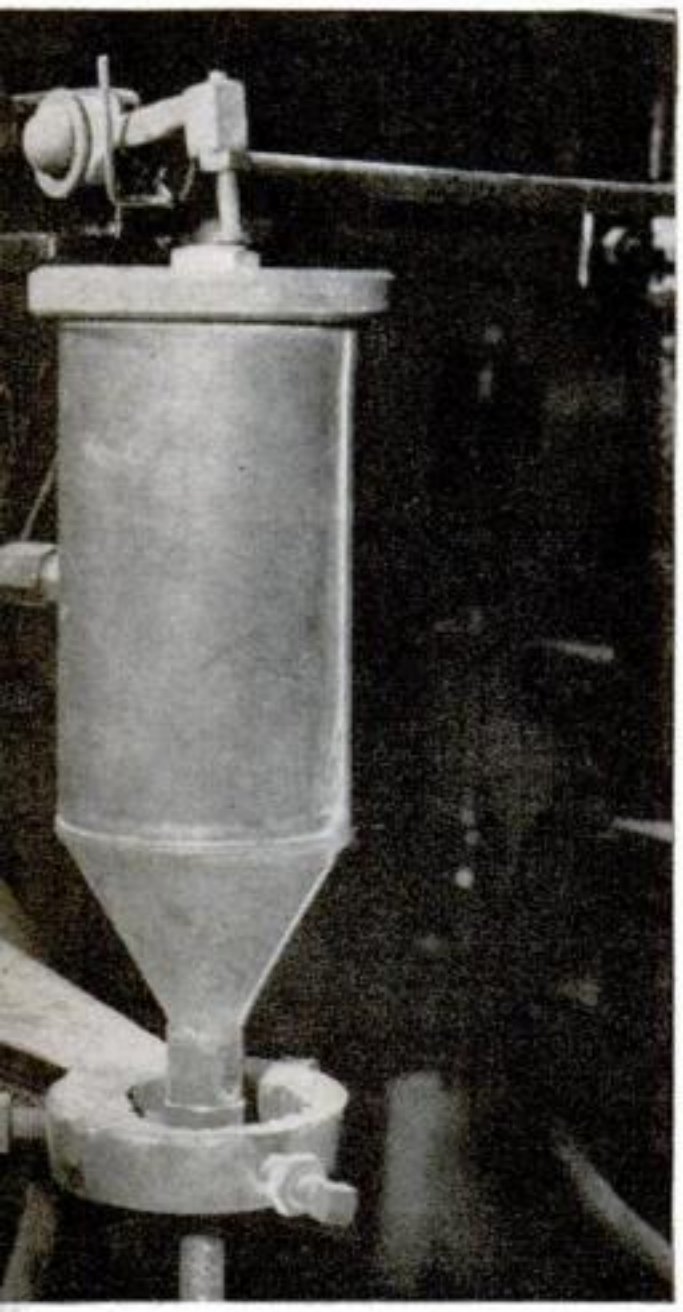
Synthetic Jewels

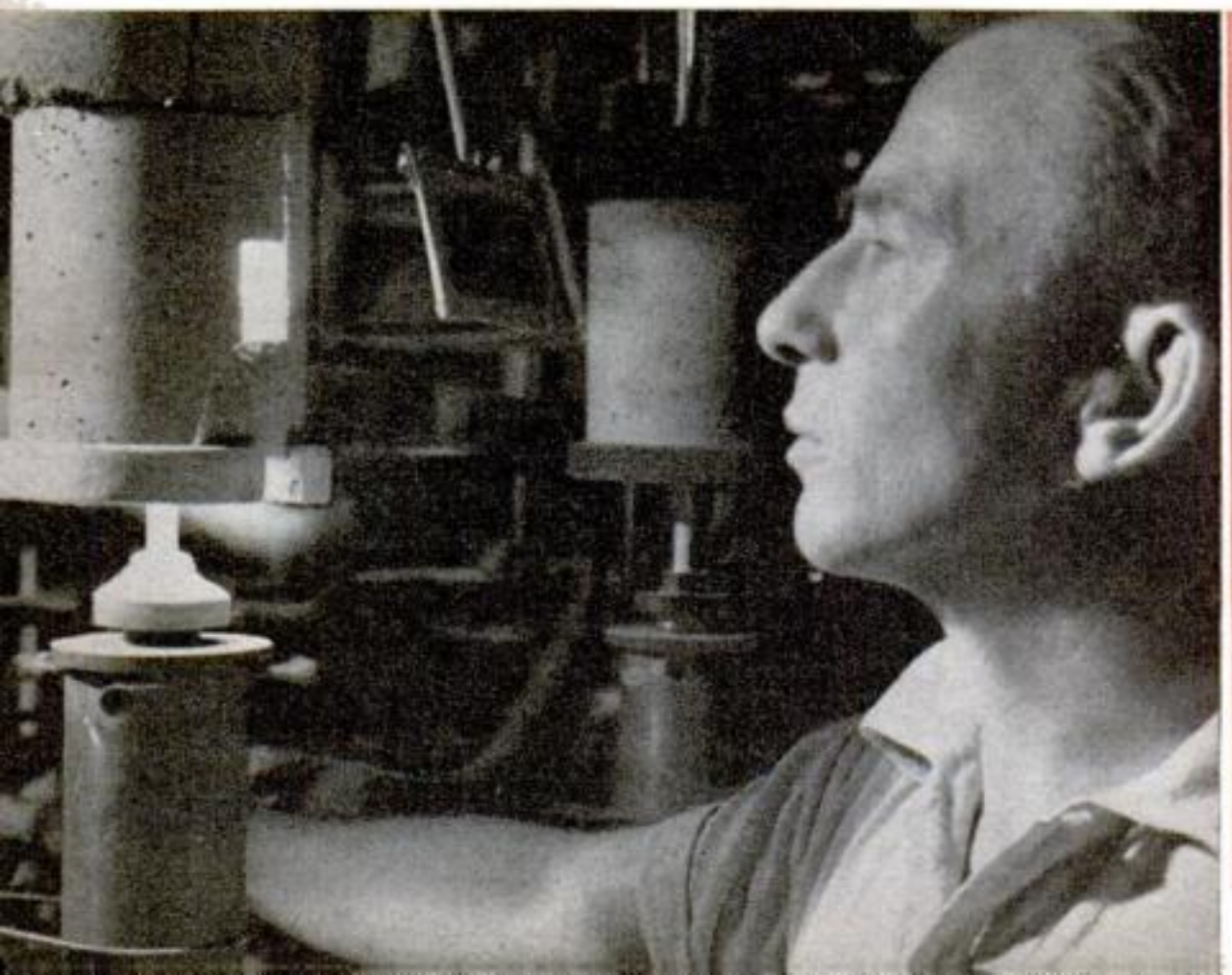
NEW INDUSTRY MAKES BEARINGS FOR WAR INSTRUMENTS

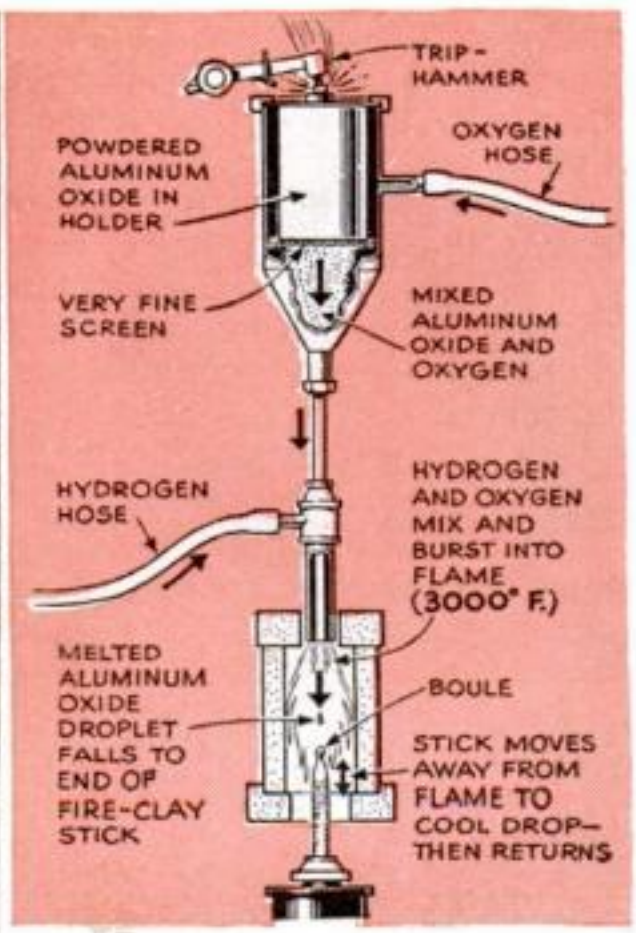


NATURE makes rubies and sapphires by fusing aluminum oxide in her own laboratory, the volcano, under terrific heat and pressure. Man can do the same job by dribbling aluminum oxide into an extremely hot flame formed by the union of oxygen and hydrogen, and catching the melted droplets on the end of a pointed stick. If the aluminum oxide is pure, the droplets become a white sapphire. If man wants rubies he adds to the aluminum oxide, as Nature does, from one to two percent of chromium oxide; if blue sapphires, a pinch of titanium oxide. The stones thus formed are not imitations; they are identical with the natural product in hardness, chemical composition, specific gravity, and index of refraction. For industrial purposes, specifically bearings, the synthetics are superior because they are virtually flawless.

In peacetime no synthetic jewels were manufactured in the United States, but American industry imported from Europe, principally Switzerland, about 200,000 carats a day, of which 75 percent were used in watches, water and electric meters, and precision instruments requiring non-magnetic bearings. The war practically wiped out these imports, and at the same time enormously increased the demand. Jewels for bearings are essential to the success of the American war effort, for without these tiny pieces of fused alumina, no bomber could stay in the air, no watch would keep accurate time, and no warship could be navigated. More than 5,000 jewels are used in one battleship, including 4,000 in the engine room, about 100 in the fire-control mechanism, and another 100 in the navigation instruments. The instrument panel of a single bomber

1 Man-made sapphires, from which jewel bearings are cut, are created by fusing aluminum oxide under extreme heat. Oxide is first placed in this container where it mixes with oxygen. Passing down to burner below it contacts a flow of hydrogen. There the two gases ignite at 3,000 degrees Fahrenheit and melt the oxide into a tiny droplet which falls to a waiting clay stick entering burner from bottom





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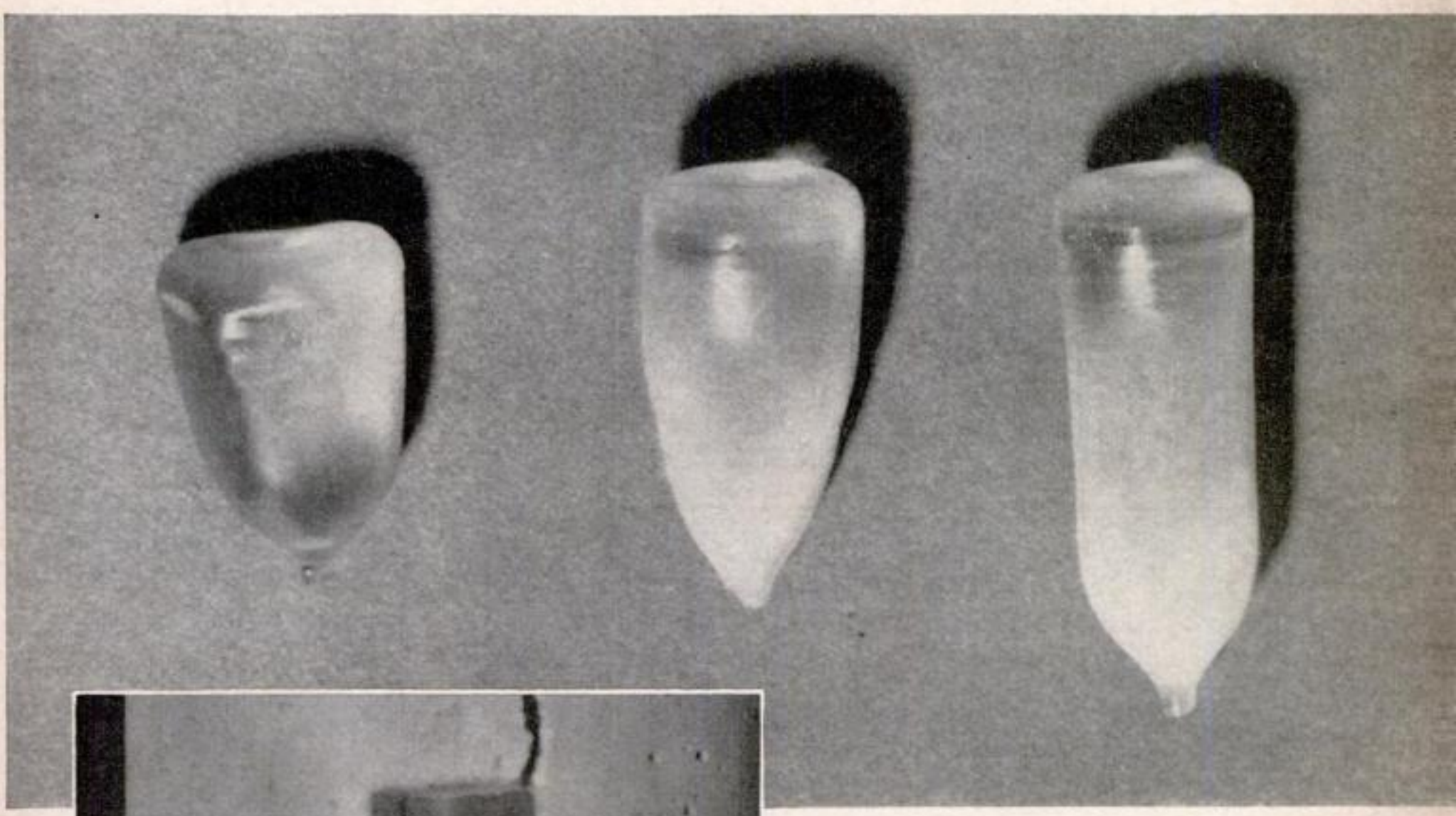
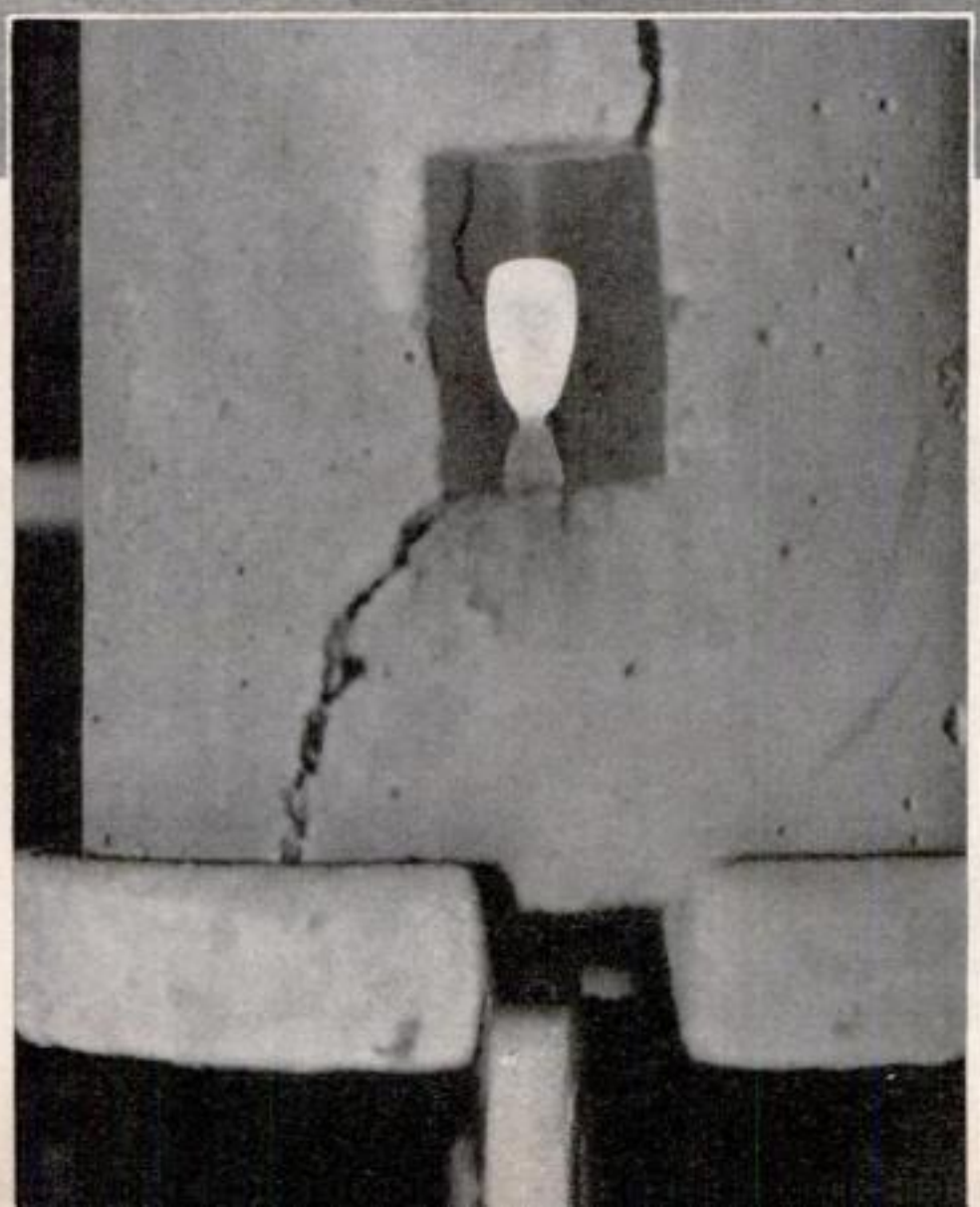
contains approximately 100 jewel bearings, an undisclosed number go into the manufacture of a bomb sight, and millions are needed for ring and pivot bearings in small electrical instruments, electronic control devices, range finders, and other military and naval apparatus. The largest of the ring bearings is not more than a few millimeters in thickness, circumference, and diameter, and the jewels used for pivot bearings are even smaller, about one millimeter in diameter and 9/10 of a millimeter thick.

Almost two years ago, foreseeing a possible shortage in these vital materials, the Office of Production Management asked American chemical firms to undertake the manufacture of synthetic jewels, and experiments were begun in several plants. Some four months after Pearl Harbor this work began to show results. In May the Union Carbide & Carbon Company began producing considerable quantities of synthetic stones, and in August the new firm of Synthetic Gems & Jewels, Inc., put 40 furnaces in operation, with 60 more ready to be installed. Soon after the first of the year the Bulova Watch Company will start production in a new building with more than 200 furnaces. None of these machines will make anything but white sapphires, since no particular advantage is to be gained by coloring the stones. The only rubies and blue sapphires now being made into bearings are from prewar stocks. [*CONTINUED*]

Photographs made at the Bulova Watch Company and Synthetic Gems & Jewels, Inc., by William Morris and Robert Smith r





2 From the burner come these crystals, called "boules," each of which is an accumulation of hundreds of drops of fused oxide. As the burner's clay stick catches each droplet, it is lowered to reduce the temperature and thus the droplet is crystallized. The clay stick is then returned to its former position where the gradually growing crystal awaits the next melted drop of oxide. Depending on its size, each boule takes from two to six hours to form. By watching the formation process through the furnace's opening shown at left, and by maneuvering the clay fire stick, the operator can control the boule's size and shape

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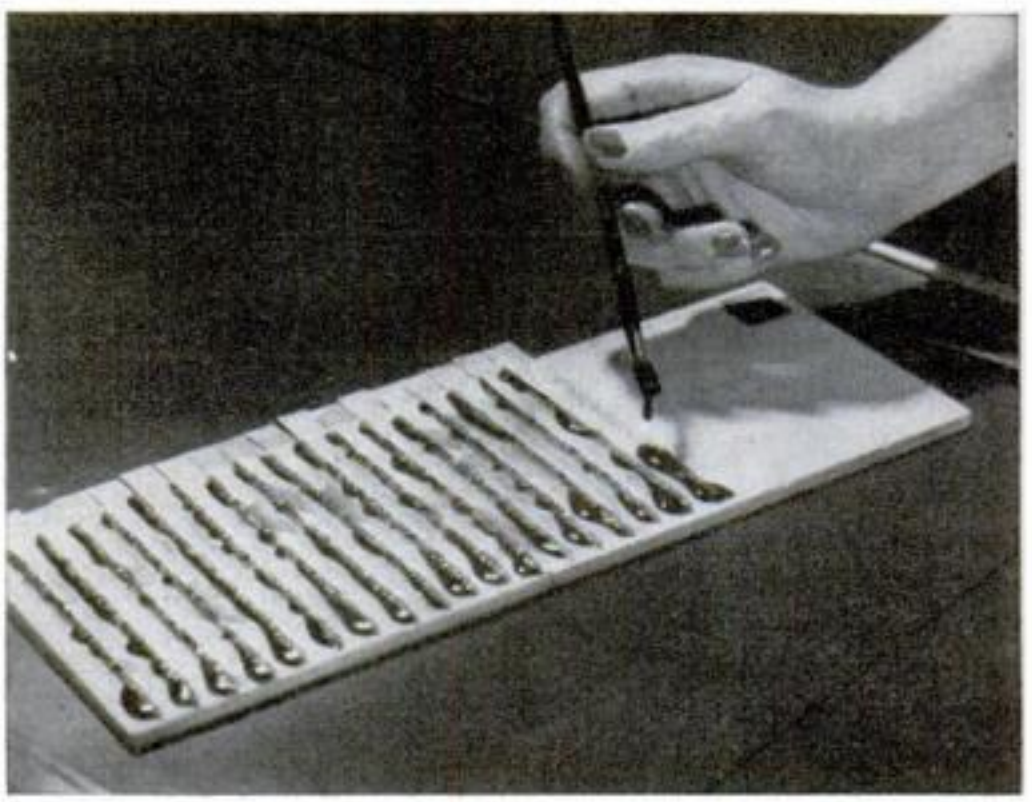
3 After the boule is removed from the furnace it is split lengthwise into two approximately even pieces. Each is examined for flaws and then fixed to a small board with sealing wax

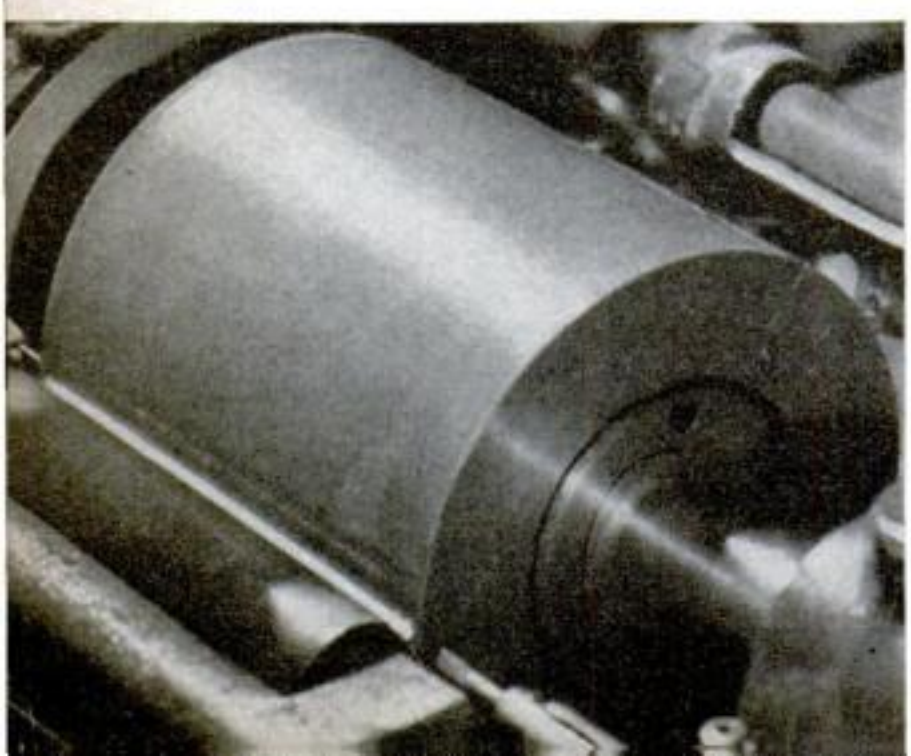
4 The half-boules are then cut by a revolving saw which slices them into "half-moons" about 1/32 of an inch thick. The saw blade, a copper disk, has been impregnated with diamond dust

5 These squares, cut from half-moons in varying sizes which are determined by the purpose to which the ultimate synthetic gem will be put, are being sealed on disks for rough grinding



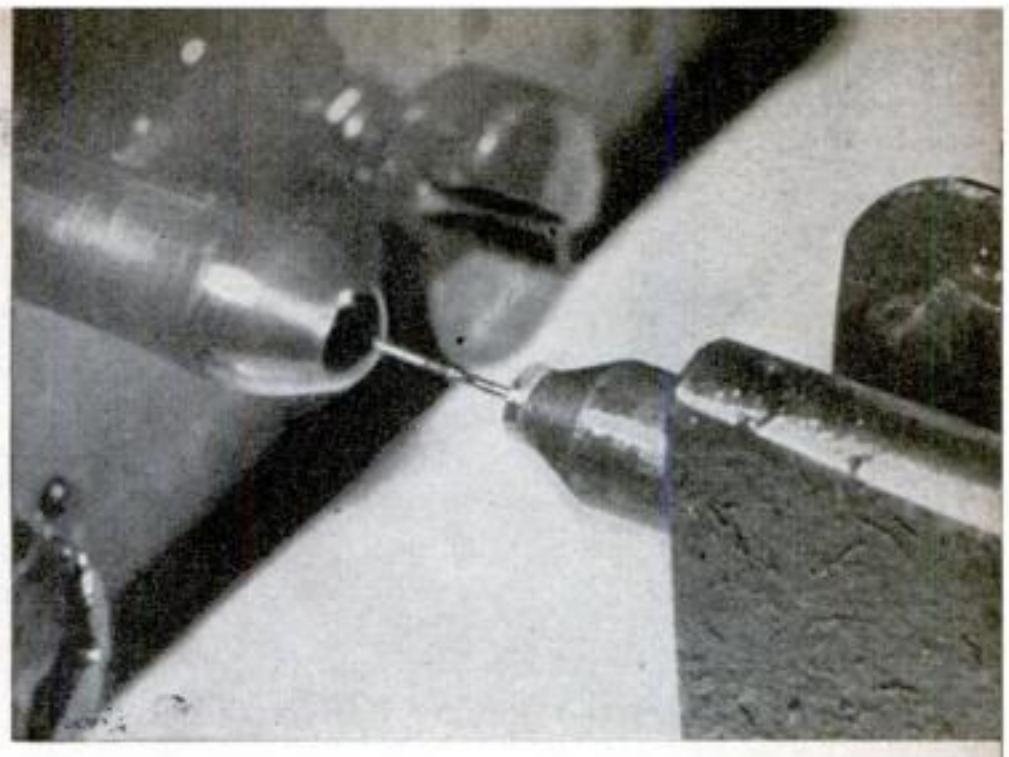
6 Here the tiny squares are shown lined up on a piece of paper and held together by molasses. When jewels are at this stage, they are ready for piercing, grinding, and polishing to size

7 In this operation, the outside radius of the gem—or "jewel blank" as it is called at this point—is being ground between rollers. Forty-odd important operations still await the blank

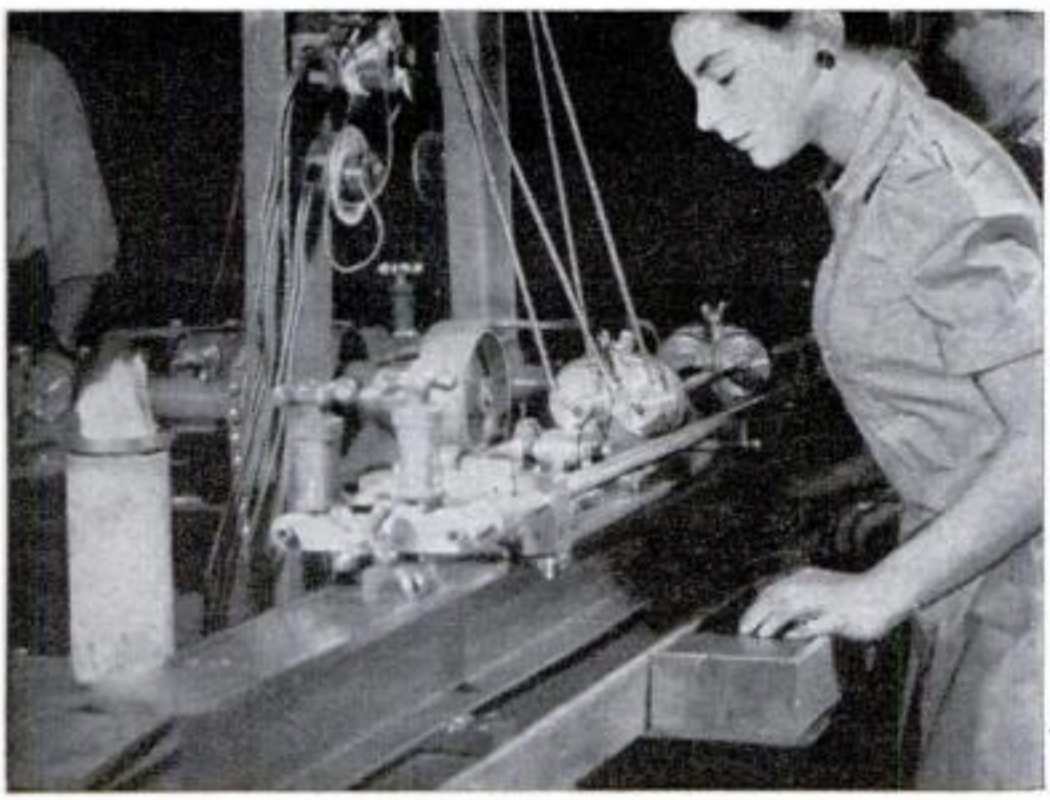


8 Preparatory to piercing, the jewel blank is glued to the end of a small steel rod. In none of the operations producing the gem can there be a tolerance of more than 3/10,000 of an inch

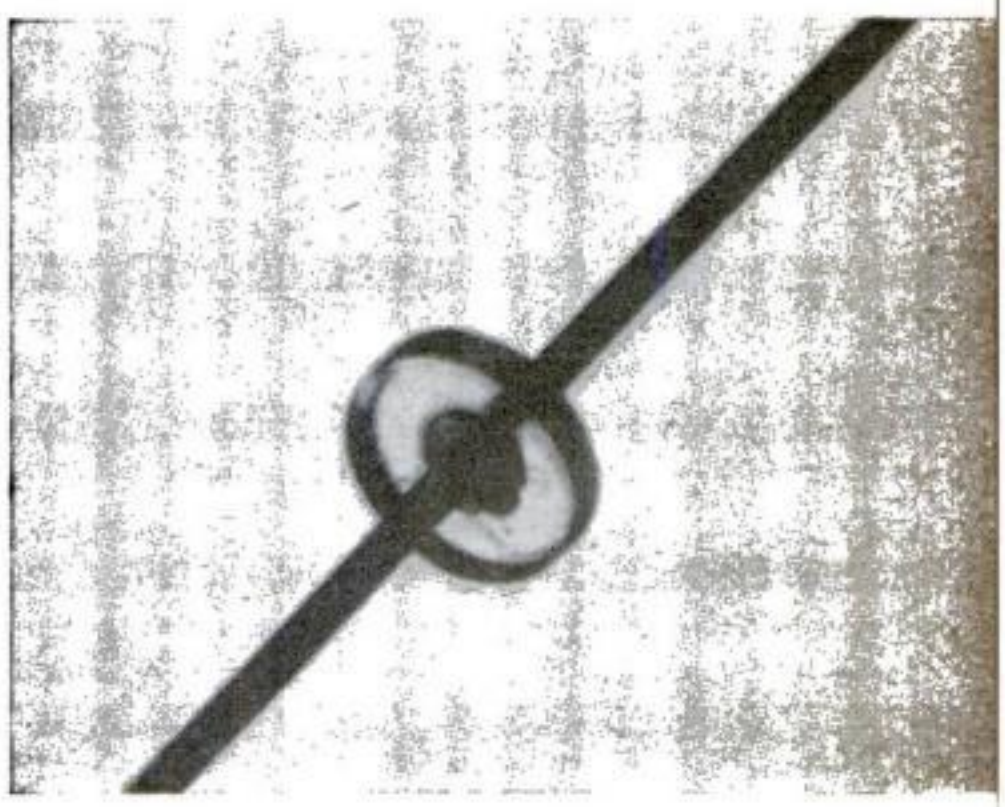
9 The steel rods are placed in this automatic 24-drill machine, diamond dust is applied, and a hole 7/1,000 of an inch in diameter is carefully cut through the center of each gem



10 A close-up of the tiny drill cutting through the jewel. If gem is to be a pivot-bearer, a small V-shaped depression is cut into it, in which the pivot point will rest and rotate

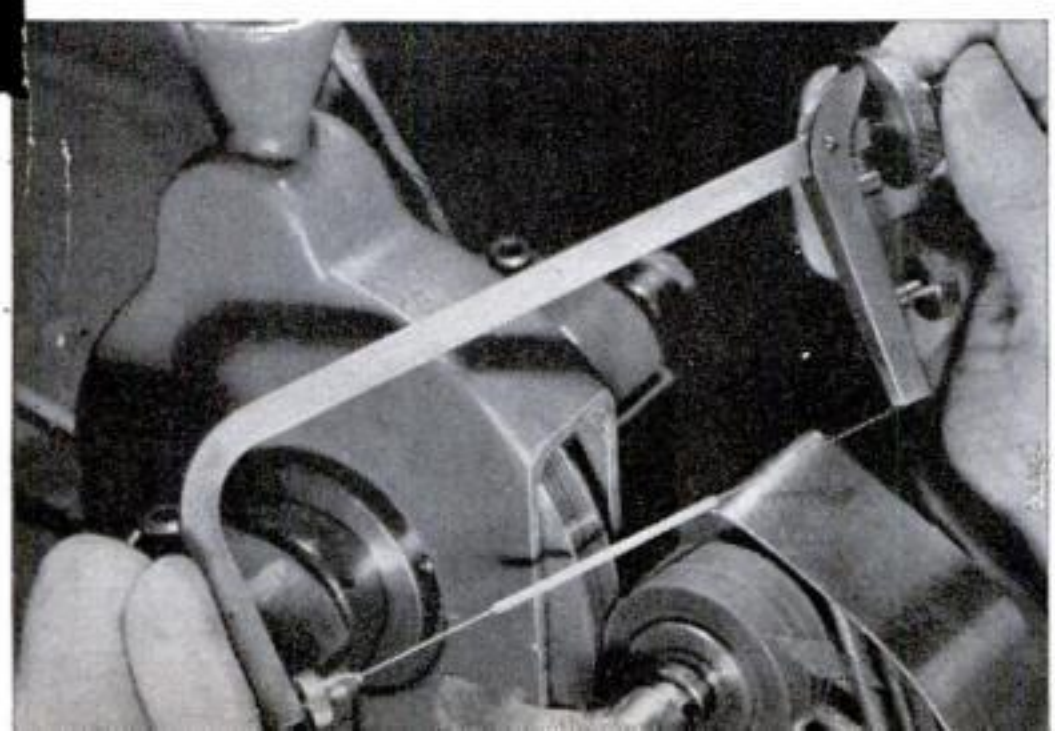


11 The pierced jewel is now placed in this hole-enlarging machine. A tapered wire charged with diamond dust is drawn back and forth through the hole, enlarging and polishing it



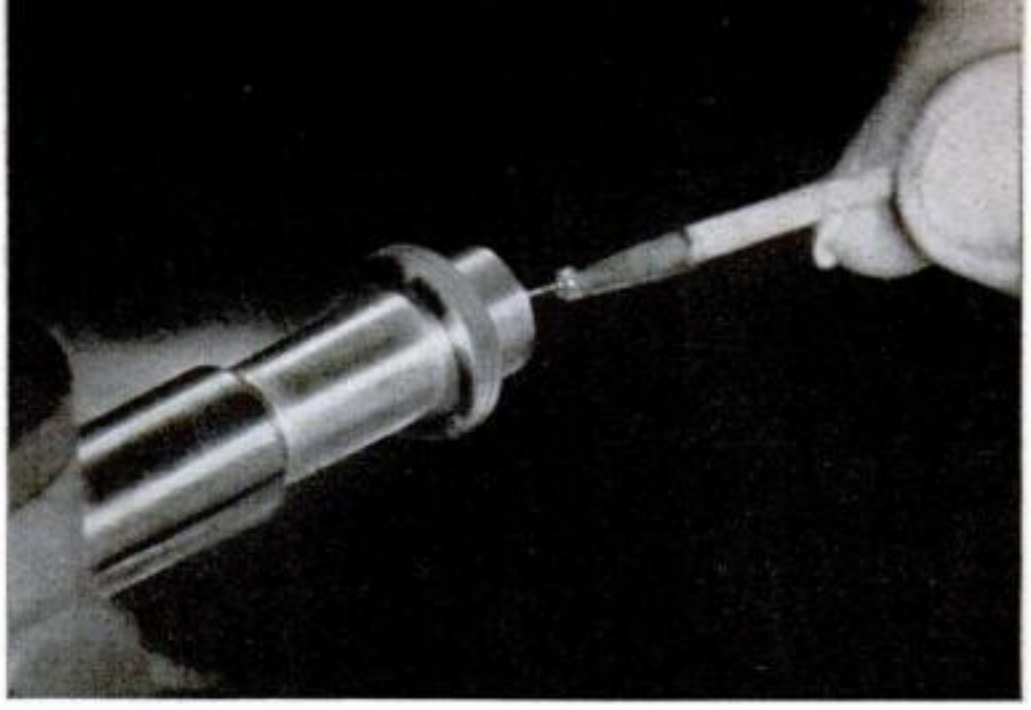
12 The jewel as it appears when strung on wire. Depending on the final use to which gem will be put, the diameter of the hole may be enlarged up to 21/1,000 of an inch

13 After having strung the gems on the wire of a "bow," the operator holds them against a grinding wheel, turning the outer radius to proper size and concentric with the hole

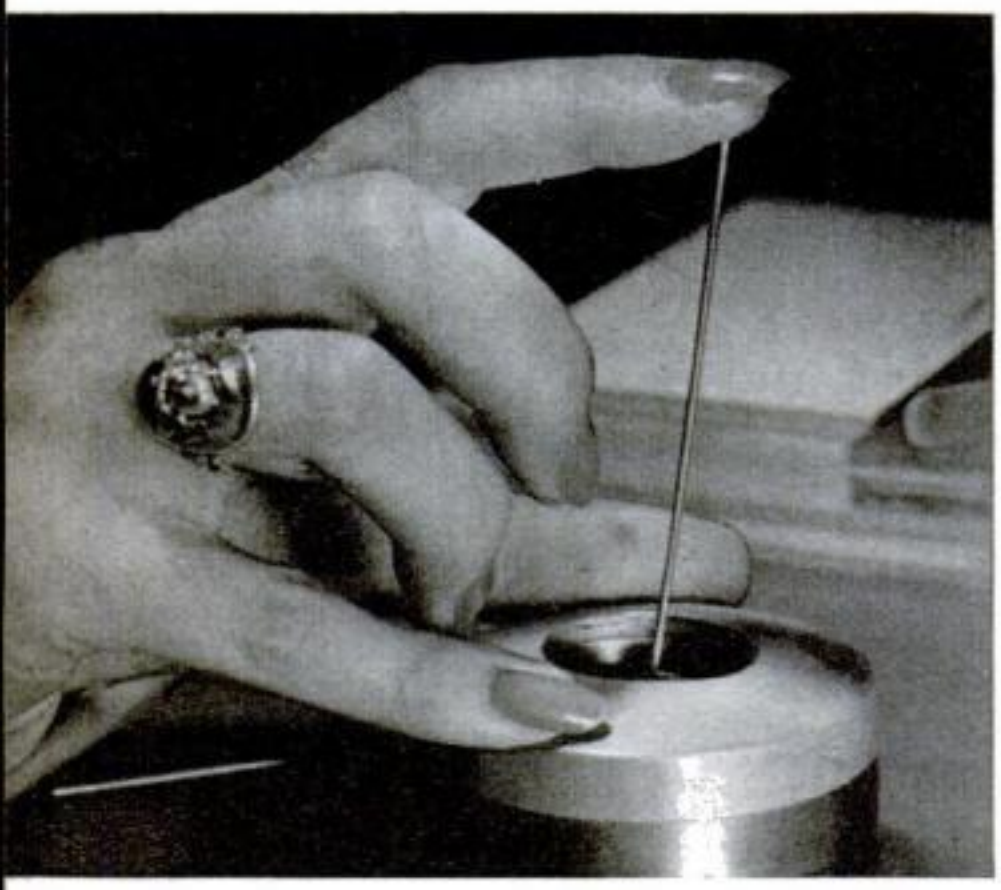


14 The next step is "cupping"—a delicate process in which a small recess is cut around the hole as an oil reservoir. Half a drop of oil will lubricate a jewel for eight months

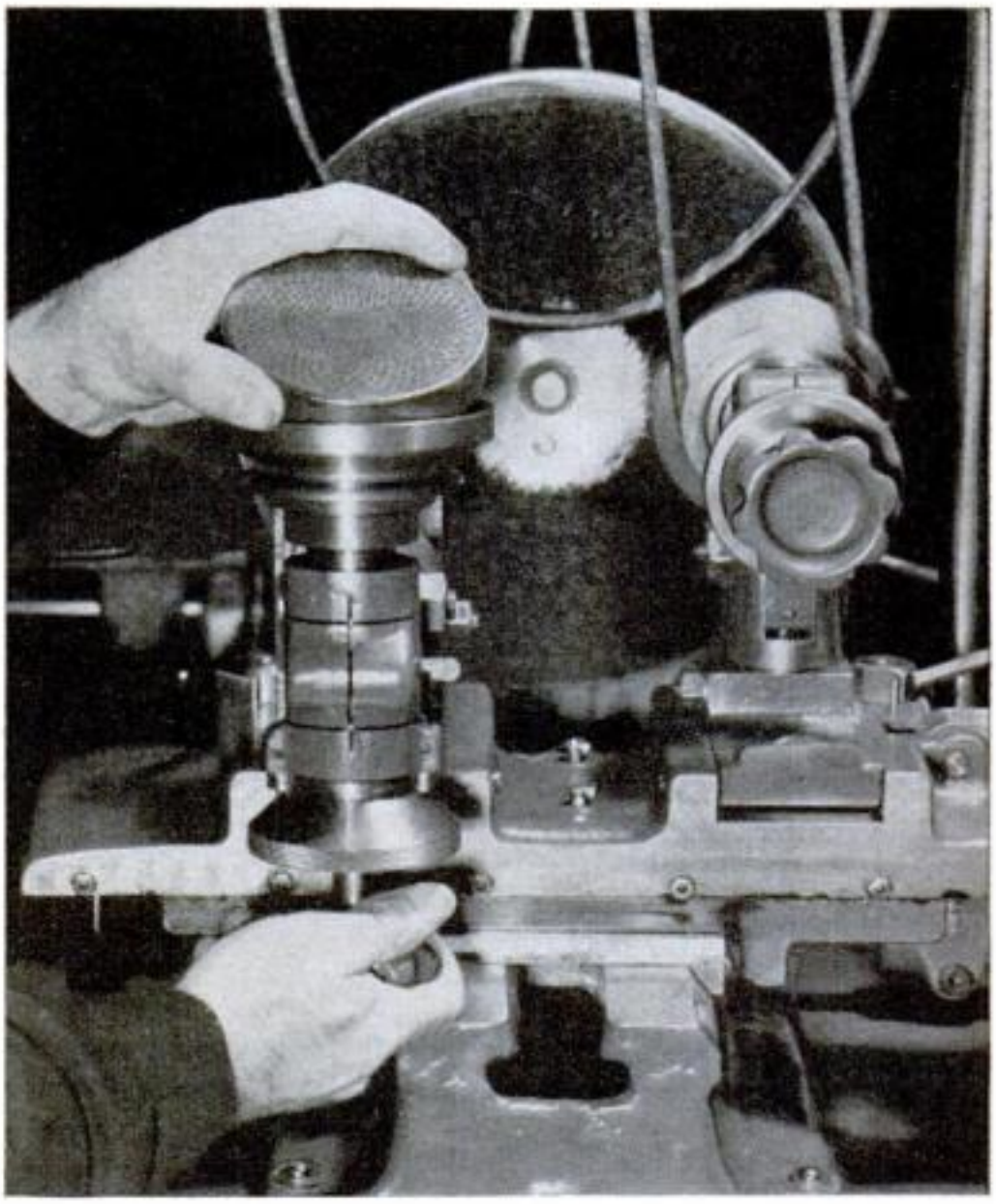
15 An enlarged photograph showing the details of the delicate "cupping" operation. Cupping is done by means of three small drills, each of which is set at slightly acute angle, as shown



16 Here the inner radius of the gem is being ground by a thin wire charged with diamond dust. Note that wire is held at an angle so as to permit the jewel shaft to ride at a tangent



17 Beveling the hole of the gem is done by means of oil, diamond dust, and a pointed copper wire rocked back and forth by hand. Outer edge is beveled by tumbling gem in Carborundum



18 After beveling, the gems are put in this brushing machine which spins in one direction for a minute, then the other way for another minute

The Bulova Watch Company has also pioneered in the manufacture of completed bearings from the rough stones, which are called boules. In less than a year the company designed and manufactured, in a specially built machine shop, intricate machines for cutting, grinding, piercing, and polishing the jewels, and trained a large force of workers to operate them. By August, 1942, the Bulova Company was in full production on completed bearings, and in addition had built enough machines to equip and set up production lines for a dozen other manufacturers.

The process by which these stones are made is a simple one employing automatic furnaces, but it is extremely difficult to start and to control. The finely powdered aluminum oxide must be absolutely pure, it must flow evenly into the flame, and a constant temperature must be maintained. The furnaces are set up in banks, and although in various factories there are minor differences in design, essentially each consists of a container for the aluminum oxide, a rocker beam which operates a small trip-hammer, two horizontal pipes to feed the oxygen and hydrogen from tanks, a vertical pipe to

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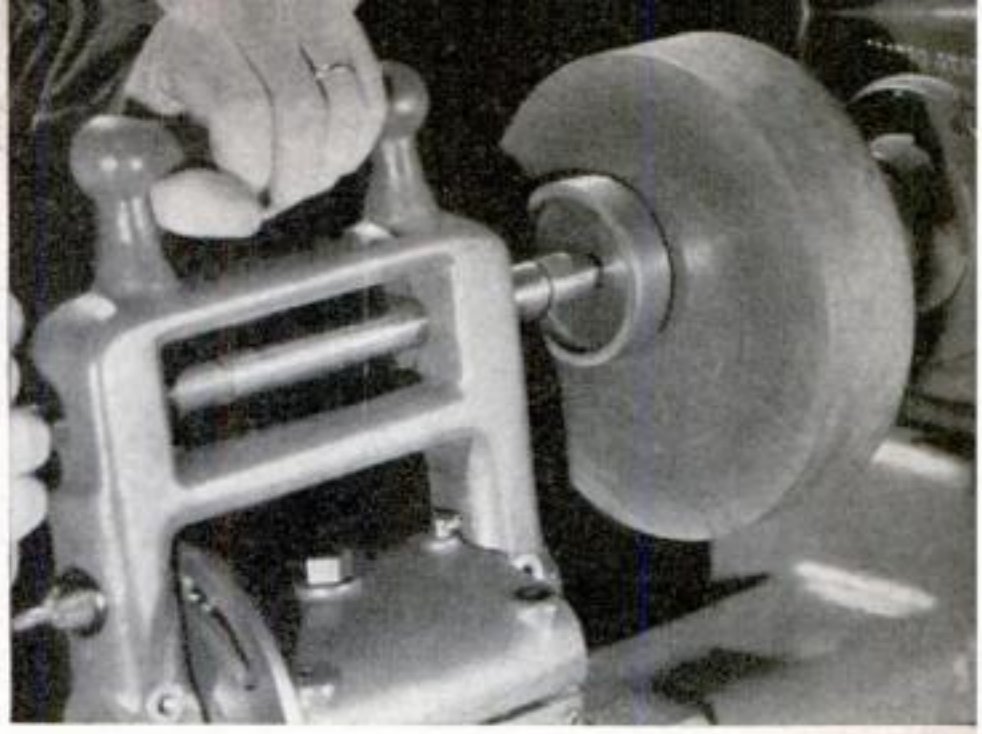
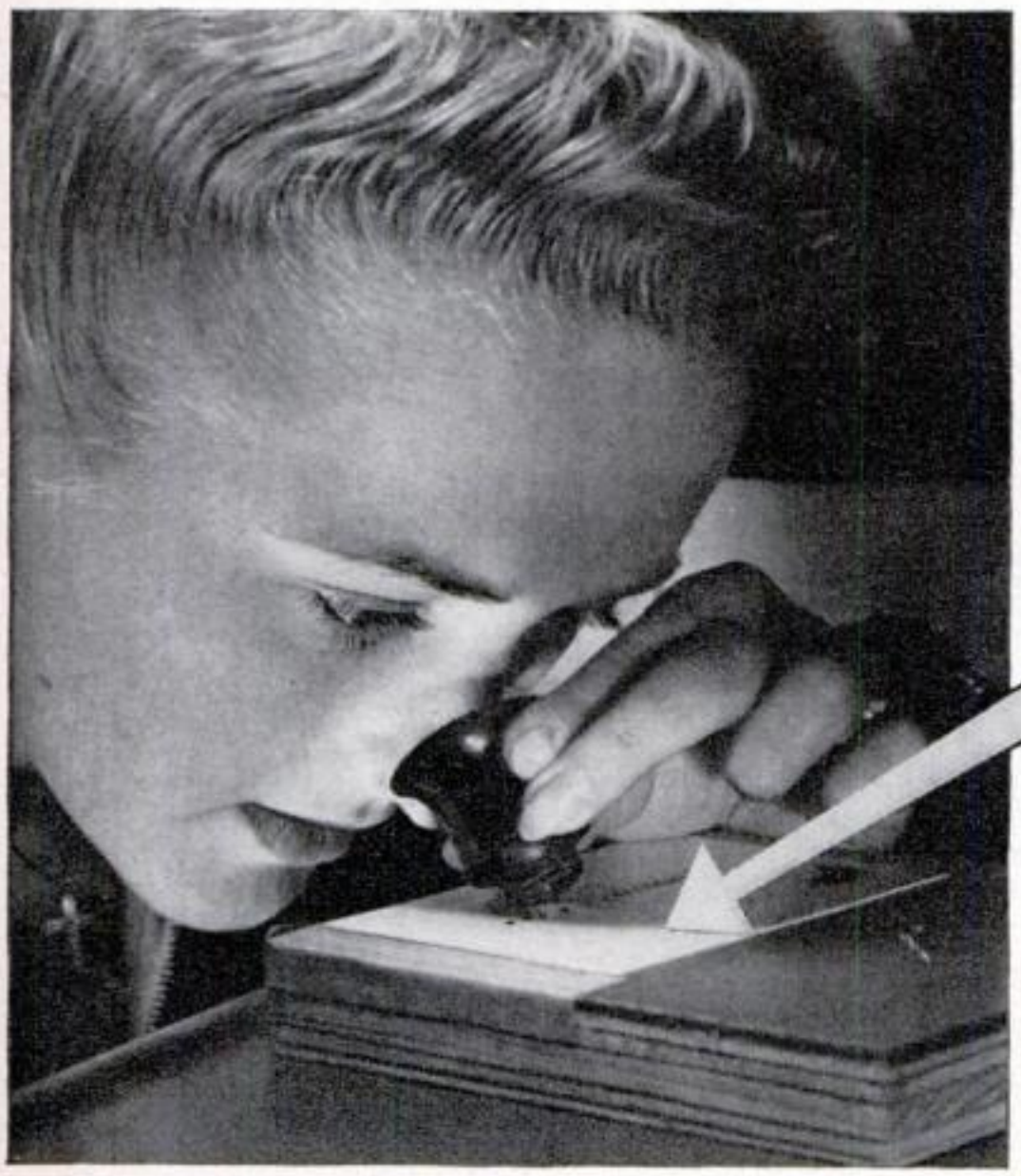
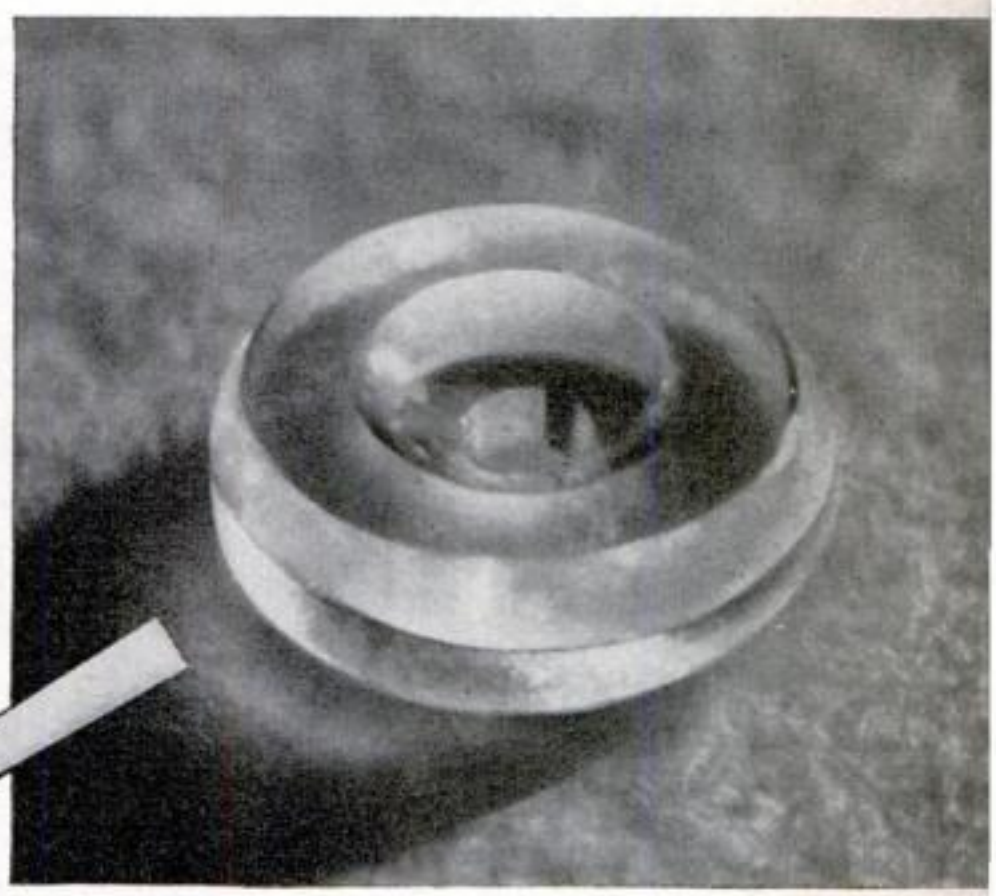
19 When they come from the brushing machine, the gems are pressed into a round linoleum block, such as that shown above. They are now ready to have their tops polished, as pictured at right



20 Now the gems, firmly held by the linoleum block, are being polished against Honduras mahogany which is used for this purpose because of its hardness and very close grain





21 The ultimate reward of a long series of arduous and delicate operations, the perfect jewel bearing shown above—without which a battleship could not navigate, a bomber could not fly, this most important of wars could not be won—gets its last inspection

carry the gases and the oxide into the burner, and the burner itself, which is made of fire clay and is about 10 inches long and six inches in diameter. Entering the burner from the bottom is a fire-clay stick, which can be moved back and forth and up and down by the operator.

After the furnace has been tested to make certain that each stage of the process is carried out with split-second precision, the aluminum oxide is placed in the container at the top of the furnace assembly. The trip-hammer strikes the top of the container, forcing carefully calculated quantities of aluminum oxide through a fine screen into the vertical pipe. There it meets the flow of oxygen, and is carried downward to the burner. Just above the burner the oxygen and aluminum oxide meet the flow of hydrogen, and the two gases burst into flame at a temperature of about 3,000 degrees Fahrenheit. The aluminum oxide immediately melts, and the droplet thus formed falls through the burner to the stick, which is then automatically lowered to a point where the temperature is reduced by about 100 degrees. This permits the drop to crystallize, whereupon the stick moves

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upward to catch the next drop. Thus there is built upon the stick, drop by drop, a single large crystal called a boule, the size and general shape of which is regulated by the operator, who watches through a window set in the side of the burner. A boule can be formed in from two to six hours, depending upon its size, which may range in length up to as high as four or five inches—a rather remarkable achievement when it is considered that each boule is a flawless sapphire.

THE boule is whole when removed from the furnace stick, but splits along its optical axis when the elongated tip is snapped off, forming two pieces of approximately the same size. From the time the half-boules enter the Bulova plant until they emerge as completed bearings ready to be installed in instruments, about 70 operations are required, including the cleaning and inspection which follow each stage of manufacture. All saws, drills, wheels, laps, and brushes used in cutting, piercing, grinding, and polishing the jewels are impregnated with diamond dust, for only a diamond, and one or two rare elements which are not available, will cut a ruby or a sapphire. On the Mohs scale of hardness these stones are 9.3, only .7 less than the diamond.

After inspection to locate possible flaws, which are seldom found, the half-boule is secured to a small flat board with sealing wax, and is then sliced by a copper saw into small pieces called half-moons, each of which is about 1/32 of an inch thick. The circumference depends upon the diameter of the boule. The half-moons are shellacked into holders and ground flat and parallel on both sides, and are then cut into squares of varying sizes, depending upon the purpose of the bearing. The squares are ground round on a copper lap and then lined up on a piece of paper and held together by molasses. The jewels are now blanks, ready for piercing, grinding, and polishing to correct size.

Most important of the 40-odd operations through which the blanks must pass before they can be fitted into metal bushings and so become bearings, are piercing, enlarging the hole, outside turning, cupping, tumbling, oliveeing, countersinking, brushing, and wood-lapping. In none is there a tolerance greater than 3/10,000 of an inch. The first operation is piercing. The blank is glued to the end of a small steel rod called a jewel arbor, and placed in an automatic drilling machine of 24 spindles, experience having shown that this is the number that one worker can operate most efficiently. Diamond dust is applied to the jewel, and the tiny drills thrust against the stone until they have pierced a hole 7/1,000 of an inch in diameter. Later this hole will be enlarged up to 21/1,000 of an inch according to the purpose for which the bearing is intended. In a few stones the holes are made as big as 30/1,000, but the number of such bearings needed is comparatively small, and they are not in mass production. These jewels are made for use as ring bearings. If destined for a pivot bearing, the stone is not pierced. Instead, a V-shaped depression is cut into it, in which the pivot rests and rotates.

The pierced jewels are strung on wires and placed in a hole-enlarging machine, where they are held in position between the spindles by resin, poured over them hot and allowed to cool. The stringing wire is withdrawn, and a tapered steel wire charged with diamond powder is drawn back and forth through the hole, enlarging and polishing it at the same time. When this process has been completed, the jewels are restrung on wire and secured in a "bow" which resembles a hack-saw frame. The operator holds the row of jewels against a grinding wheel, and turns the outside diameter to size and concentric to the hole, an operation which necessitates frequent inspection. The stones, removed from the bow and the wire, now go to a cupping machine, in which tiny drills set at an angle put a cuplike recess around the hole to act as an oil reservoir. If the cupping is properly done, half a drop of oil will lubricate a jewel bearing for from six to eight months.

COUNTERSINKING or beveling the edges of the hole is done by operators who place each separate jewel in a cup-shaped holder and rock a tiny drill back and forth in the hole until the correct dimensions have been obtained. To bevel the edges of the jewels they are tumbled in a steel drum with Carborundum, after which they are shellacked to steel plates and both sides are polished on a brushing machine which runs in one direction for one minute, then reverses itself and runs in the opposite direction for the same length of time. The jewels are then pressed into linoleum blocks, and the tops are polished flat against a block of Honduras mahogany, chosen for the purpose because of its hardness and close grain. The last of the important operations is oliveeing, in which an automatic machine puts a radius on the inside diameter of the hole which, when the pivot rotates in the bearing, will touch it only at the tangent point of the radius, thus providing a one-point bearing and minimizing friction. The edges of the hole are then beveled top and bottom, the jewel is fitted into a brass bushing, and the edge of the metal is spun over the stone. It is now a completed set jewel bearing.—HERBERT ASBURY.

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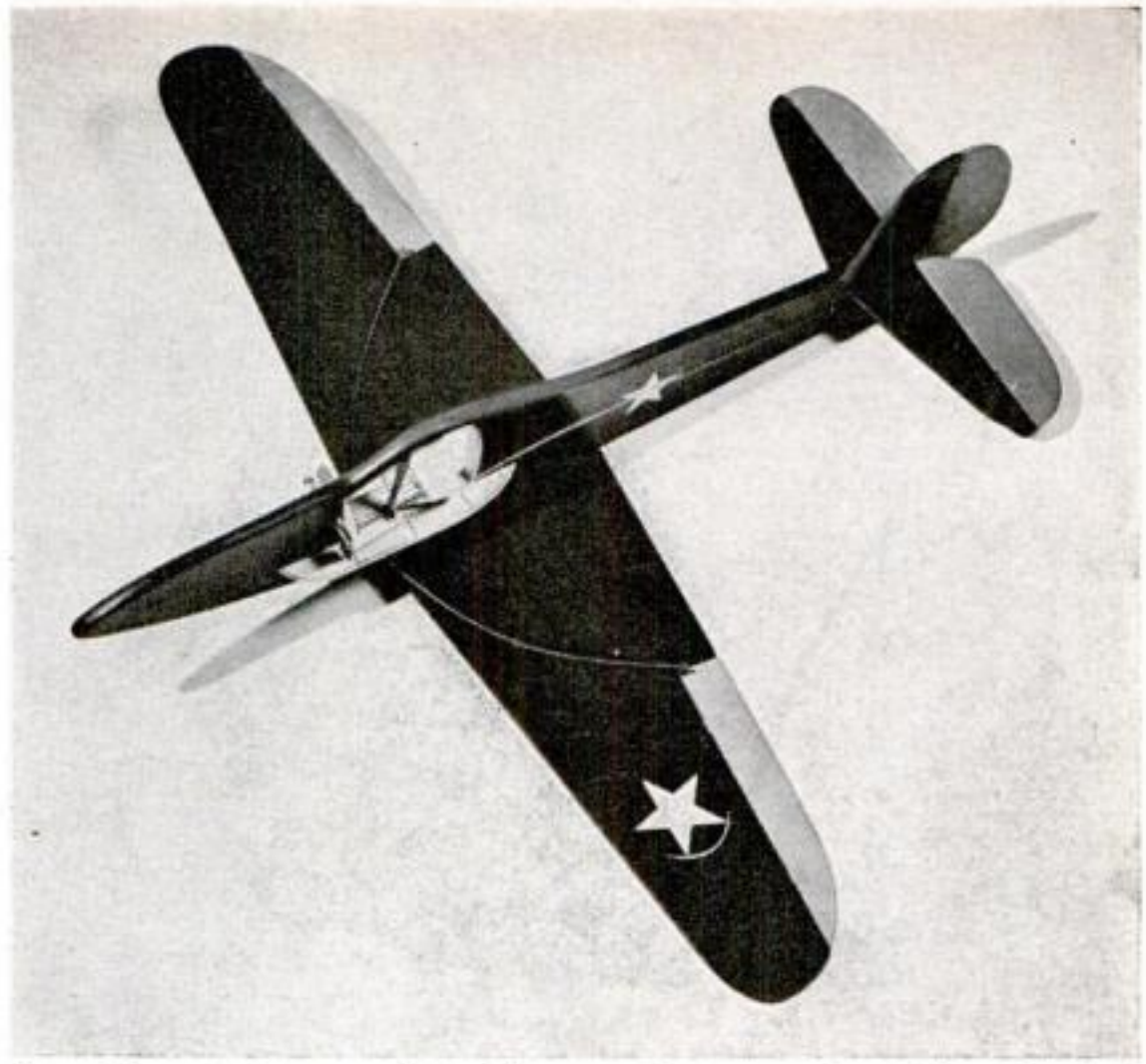
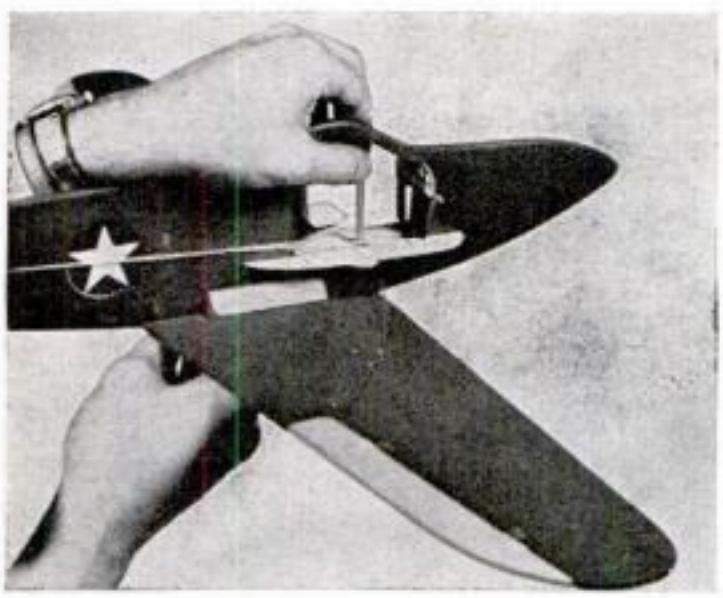
MODEL SHOWS CONTROL WORK IN AIRCRAFT

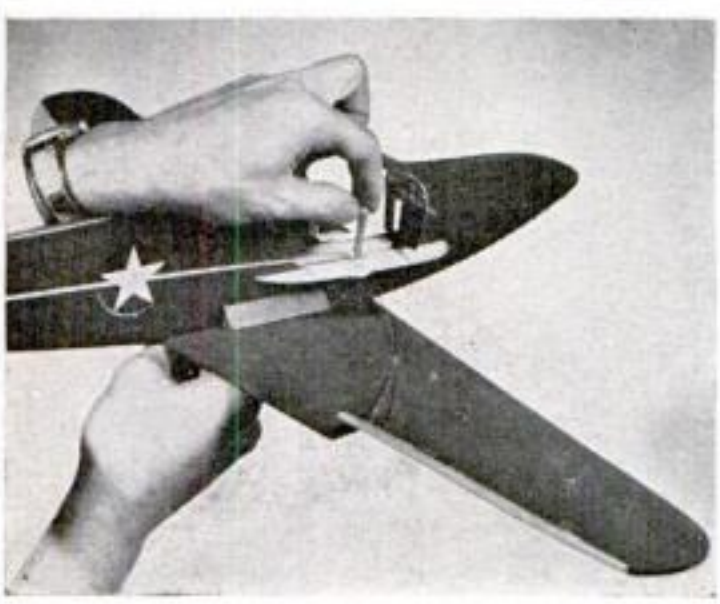


A section cut from cockpit allows student to work stick and pedals

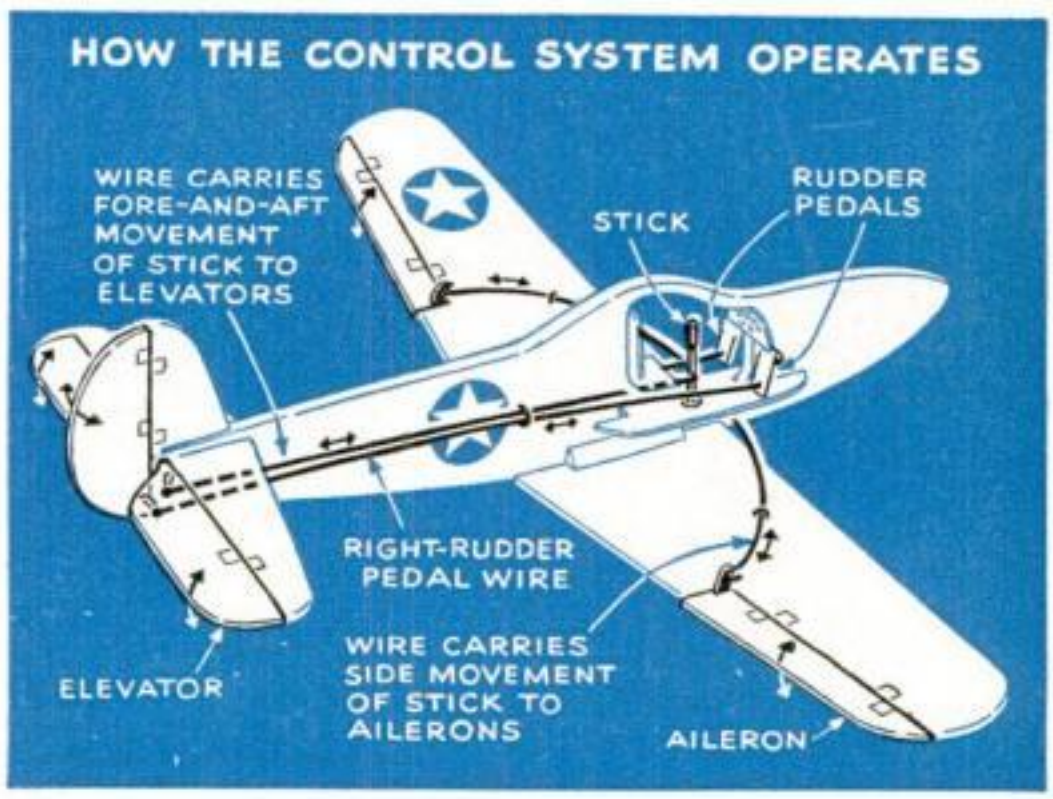
A MODEL of the famous P-39 Airacobra, with workable cockpit controls that manipulate ailerons, rudder, and elevator in exactly the same manner as in the actual aircraft, is now in manufacture at a price within the reach of any aviation student. Originally designed for use in Civilian Pilot Training Schools, it was found to be so successful that a model airplane and supply company has decided to bring it out in kit form. The model is ruggedly constructed of non-essential materials, has all parts finished, and can be assembled in about an hour and a half. Its prime value, of course, is the detailed manner in which it reveals to the student of aviation the operations involved in maneuvering a ship in flight. A section cut away from the cockpit allows the student to work the stick and foot pedals with his fingers and to observe the reaction that is produced in the ailerons, rudder, and elevator. An illustrated booklet showing in what positions the controls should be in order to accomplish the various twisting, diving, and turning maneuvers of combat flying, is included in the kit. The model has a wing spread of 24 inches.



When the stick is held at its normal position, as at left, the ailerons are level with the rest of the wing. When stick is moved to the right, as at left below, the right aileron comes up, the left goes down, and plane banks to the right



The chart below shows in detail those parts which determine the course of the plane, and precisely how those parts are controlled by the maneuvering of the control stick and pedals



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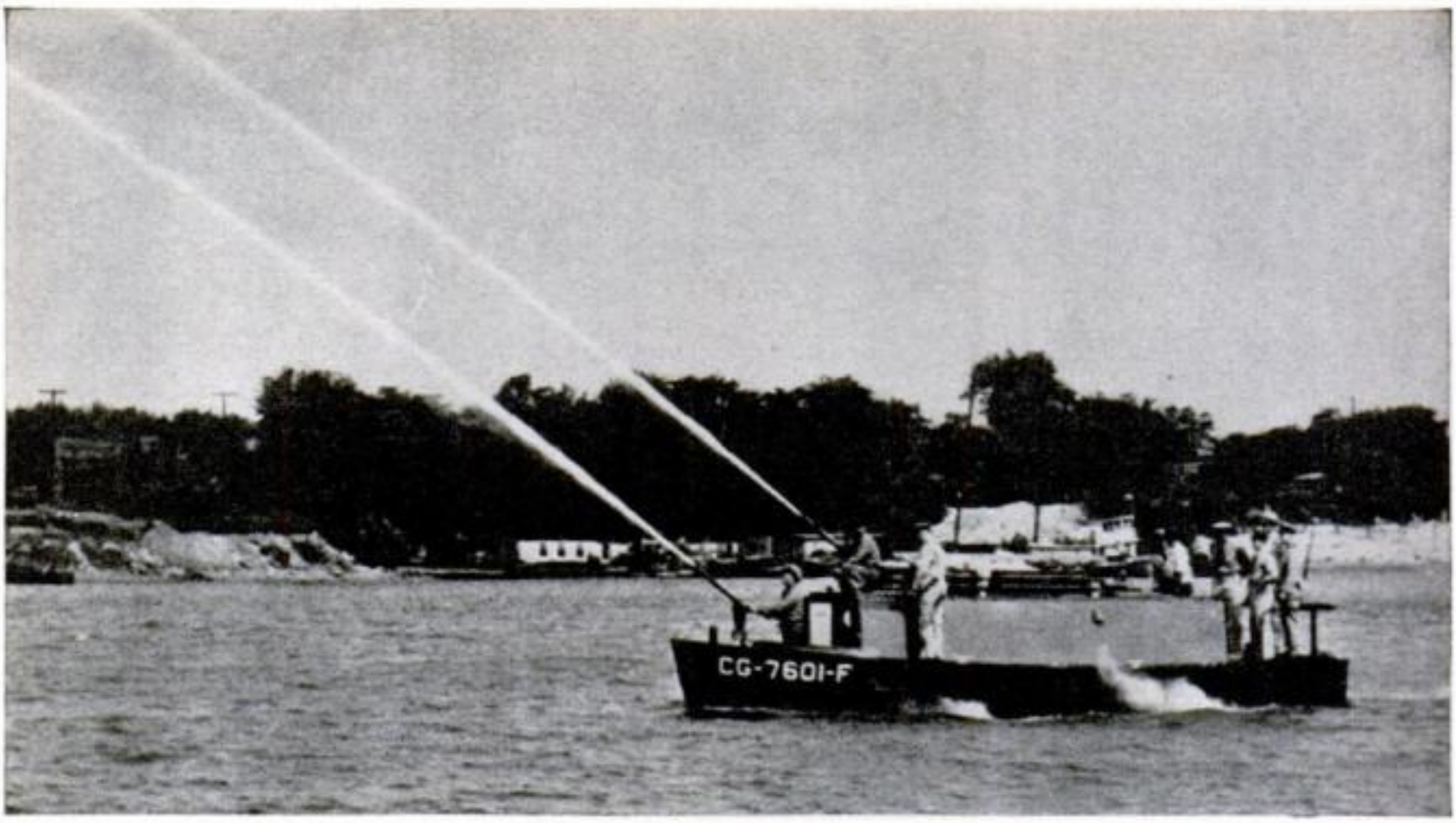

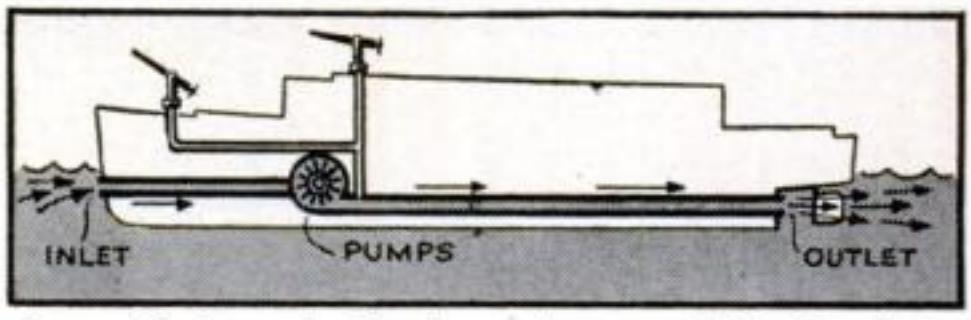

Pumps that supply the hose also propel this fire boat, drawing water in at the bow, ejecting it at the stern

PUMPS INSTEAD OF PROPELLERS provide power for the newest of the U. S. Coast Guard's fire boats, eliminating the danger of propeller damage by floating debris. These new boats, 101 of which are being built for the Coast Guard by an engineering concern in Ohio, are each equipped with four pumps powerful enough to deliver 700 gallons of water a minute through the fire hose at the same time they are maneuvering the craft. In propelling a boat forward, the pumps draw water in through a valve in the bow and eject it through a valve in the stern; when a boat is backed, the process is reversed. A draft of only 18 inches permits operation close to shore. The boats are 30½ feet long, and have a 10½-foot beam. It is estimated that each of these boats can be successfully operated with only a four-man crew.

"SWAMP GLIDERS" like that in the photo at right form an important part of the Army's "Navy" at Langley Field, Va., where they speed to the rescue of flyers forced down in marshy areas which are impassable for both land vehicles and ordinary boats. These glider boats have a draft of only six inches for negotiating the shallow water. They are driven by airplane motors and propellers, and can attain a speed of 45 miles an hour, but because of their lightness their operation is limited to smooth water.

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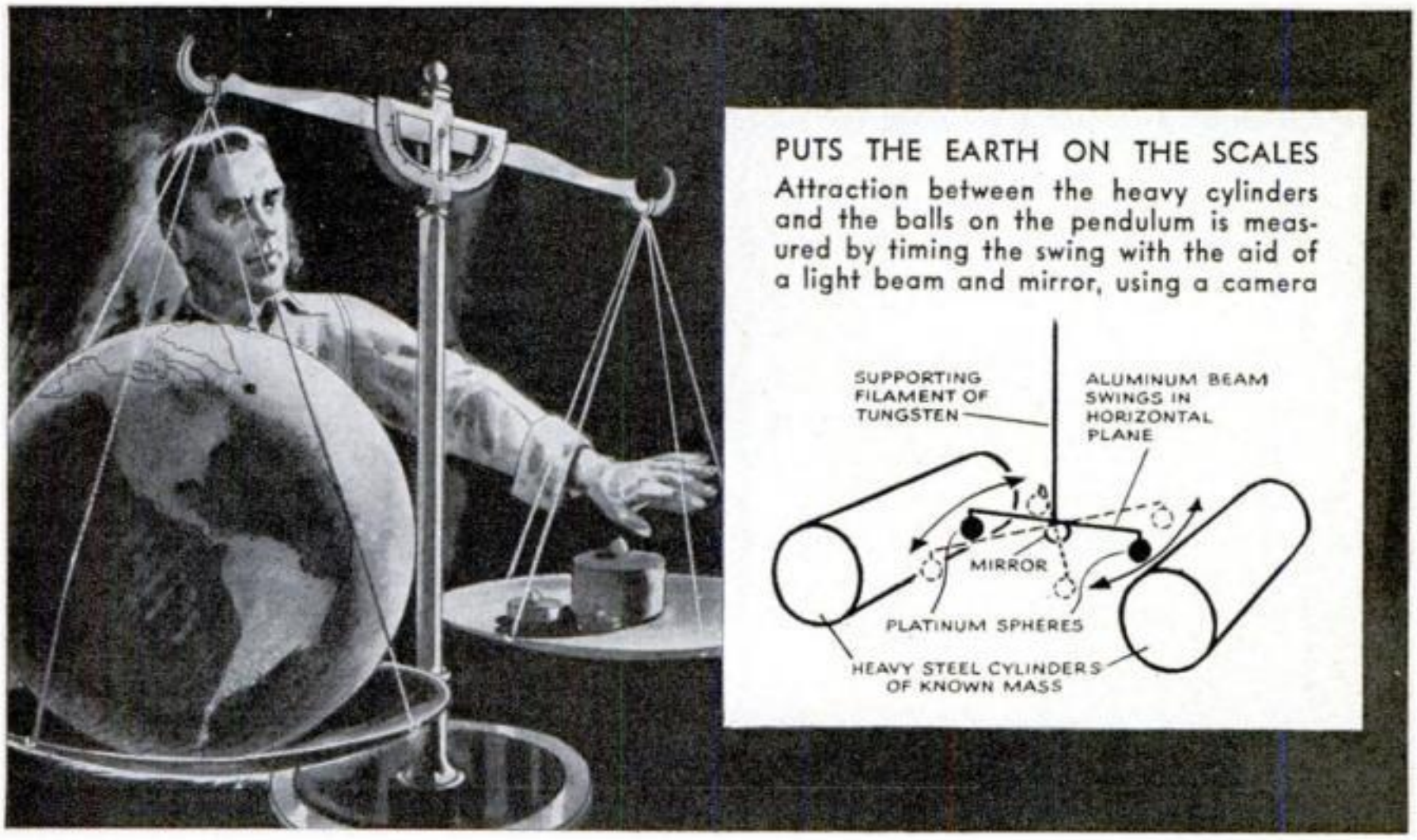
Swinging Pendulum Weighs the Earth to Find Its Mass

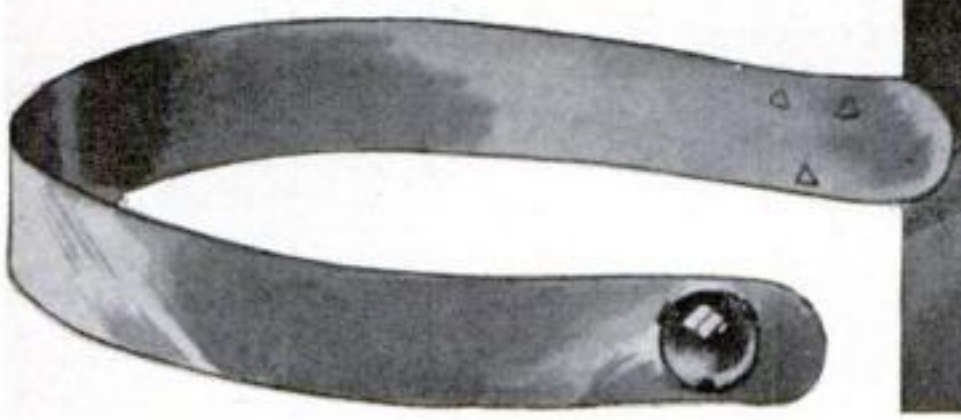


CHAMPION weigher of the earth, Dr. Paul R. Heyl of the National Bureau of Standards, has just rechecked his last figure of 1930 with improved apparatus and slightly greater precision. By timing the swings of a horizontal or torsion pendulum between two heavy cylinders of known mass, he and an associate, Peter Chrzanowski, measured the constant of gravitation, which scientists call "g" for short. This fundamental figure, in turn, makes it possible to calculate the mass of the earth.

At least two good reasons exist, Dr. Heyl tells POPULAR SCIENCE MONTHLY, for putting our planet on the scales. First, the mass of the earth serves as a standard of reference for the masses of other bodies of the solar system. Apart from astronomy, knowledge of both the mass and the size of the earth show its average density—about 5½ times as great as that of water. Since the density of surface rocks averages about 3, underlying material obviously must be much heavier—supporting the modern theory of an iron core at the center of the earth.

Reflectors on Shoulder Clip Guard Pedestrians at Night

TO SAFEGUARD children and other pedestrians at night, a highway patrolman, Raymond Trask, has invented a spring clip to be worn over the shoulder. Red reflector buttons glow at a car's approach.



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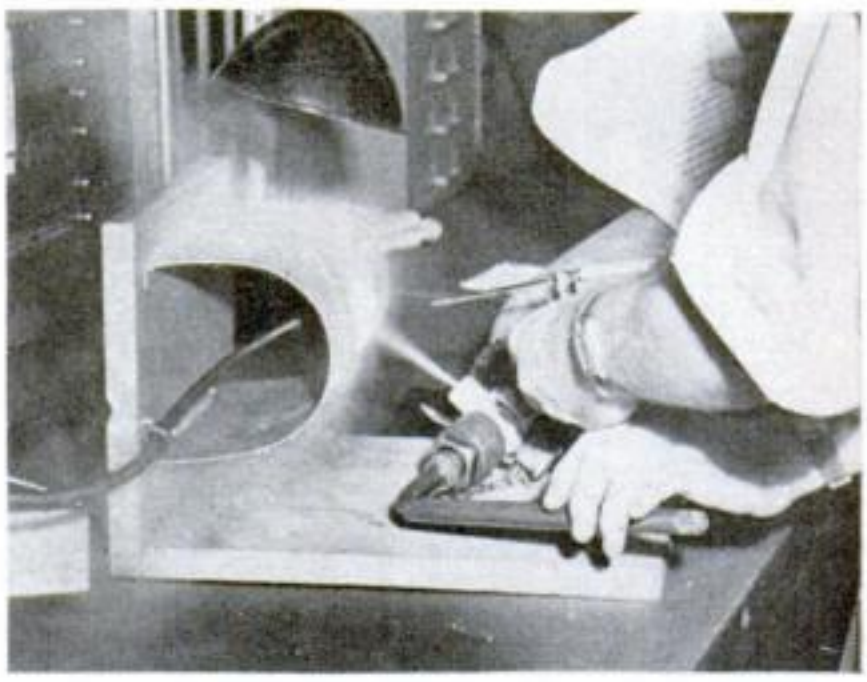
PLASTIC MASKS PROTECT WORKERS IN WAR PLANTS Eyes, throat, and lungs are shielded against flying particles of metal and dust by this mask fitted with clear plastic lenses and a plastic respirator that is packed with several different filters for as many types of fumes. The masks are being turned out by mass-production methods to equip plants engaged in America's speeded-up war work, and are a refinement of the familiar goggles long used in this country in counteracting industrial hazards. As worn by the young woman in the photograph, it would seem also to be a safeguard against disfigurement of the beauty of the hundreds of thousands of women workers who are doing their full share of our country's war work.

IODINE IN SEALED GLASS CAPSULES, protected by plastic tubes and tipped with compressed absorbent cotton, are part of the first-aid equipment of the men in our armed services. Pressure on the tube breaks the glass, allowing iodine to saturate the cotton swab for immediate treatment of wounds, as shown below. The capsules are also included in the first-aid kits of utility-company linemen and other industrial workers.



AUTOMATIC DE-ICING OF PLANE WINGS is accomplished now through the use of an electronic ice indicator. The sensing element is a plastic disk—shown above installed on a test section of the leading edge of a wing—set flush so as not to disturb the airfoil and connected both with an indicator and the power-supply unit of the de-icing mechanism. In the photo, the ice is being formed by artificial means.

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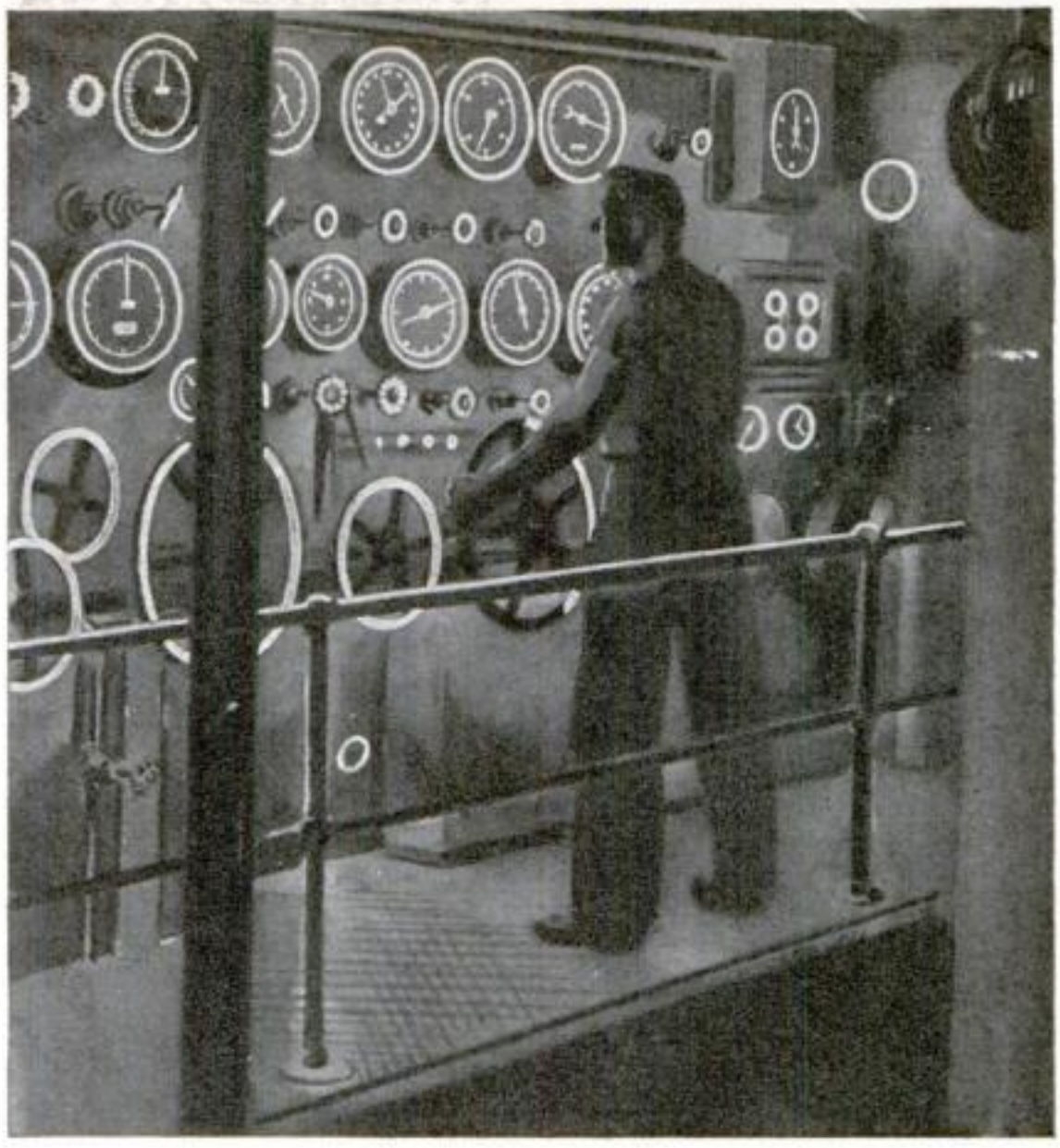
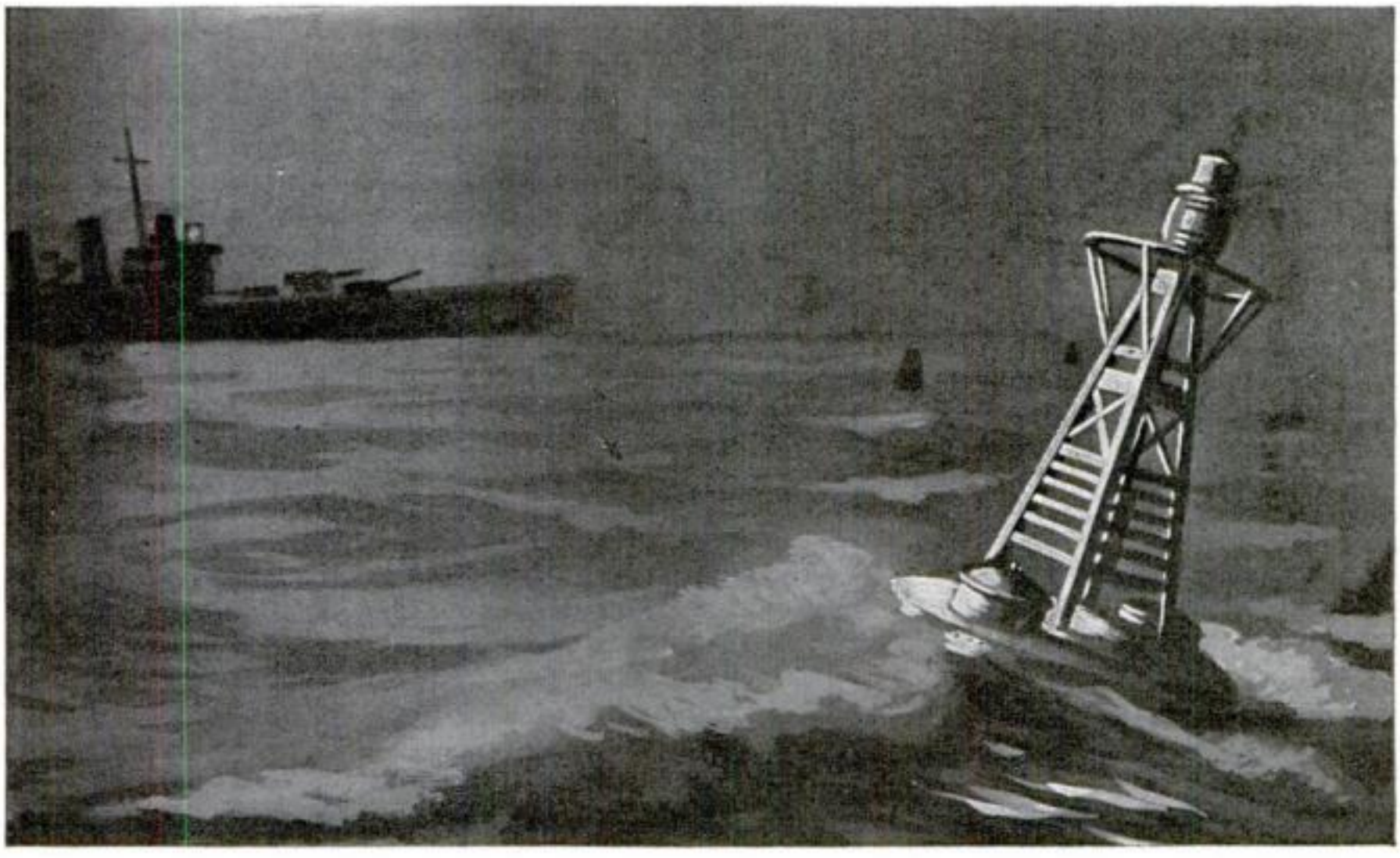
COLD LIGHT
Helps Ships Fight War in the Dark



PHOSPHORESCENT PAINT for the rims of the many dials needed in the steering and fire control of a ship is being advocated by Westinghouse engineers for use by the Navy. Prime value of this kind of paint is that it glows under black-light radiations — and would continue to glow of its own accord for several hours after an enemy bomb or torpedo had knocked out the lighting system. Also pointed out by the engineers is that the reflection from black light is invisible, and that the glare from dial glass is eliminated.

BLACK LIGHT for searchlights, whose beams could carry for several miles and yet remain invisible to the enemy, is also being recommended by Westinghouse engineers for use in marine work. The proposed searchlight is a quartz mercury lamp of high intensity, and its beam would make fluorescent buoys glow pink or red, although their daytime color would be a nearly invisible sea-green. To enable a boat to pass safely through a mine field while making it virtually impossible for an enemy boat to do so, the field could be scattered with decoy buoys which black light would not be able to pick up.



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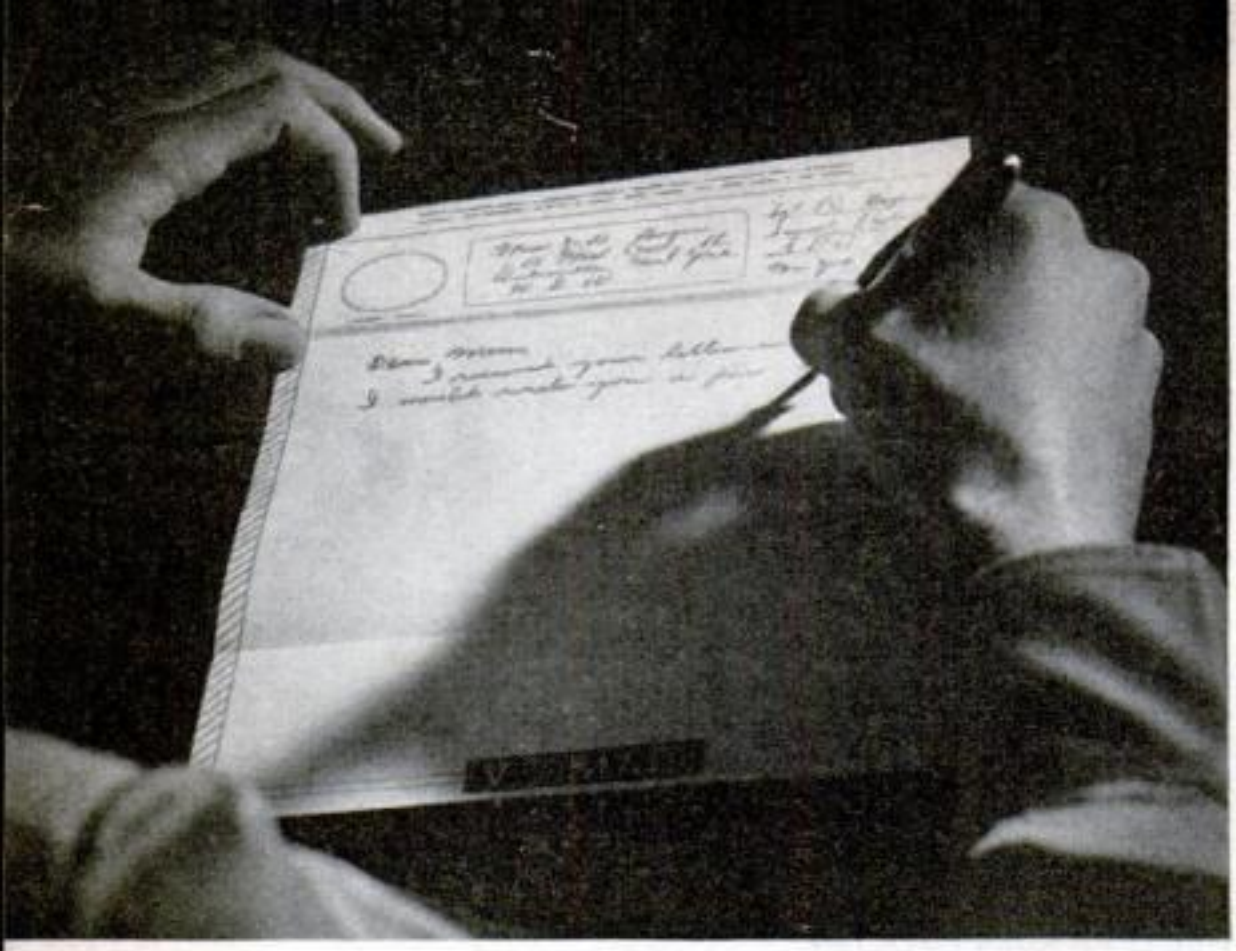


V-MAIL LETTERS must be written on special forms which can be obtained from the post office without charge. Letters are sent abroad by plane from nearest point of embarkation

MICROSCOPIC

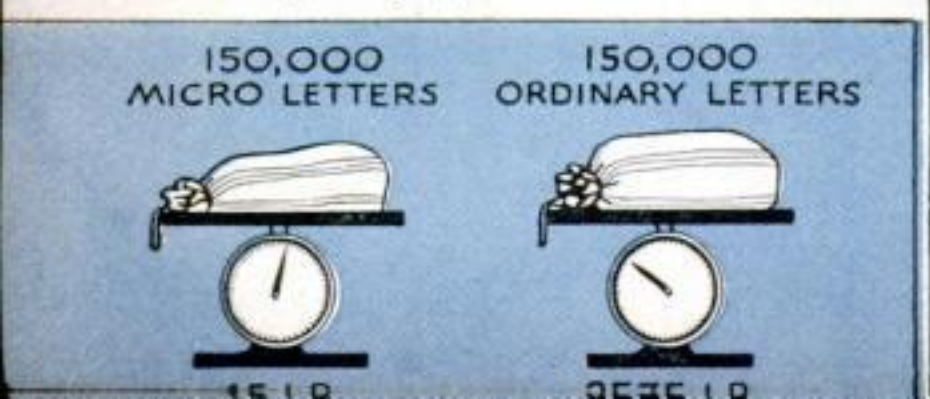
FASTEST, surest, and most patriotic way for folks at home to communicate with their soldier relatives and friends overseas is through the V-mail system which has been in use by the Army Postal Service since last June. The operation involved is a comparatively simple one. A letter, which is written on a special form supplied by the post office free of charge, is photographed down to a small negative on a 16 mm. microfilm which is sent abroad, and there

V-Mail Letters Are Reduced to 16-mm. Microfilm, Flown to . . .

1 Messages are inserted in this recording machine for photographing. As many as 1,500 letters can be photographed on 100 feet of film

2 After being developed, and prior to its being washed, film is squeegeed while being wound on a drying drum

3 To insure that its images are of adequate sharpness, the microfilm is examined in this viewing machine

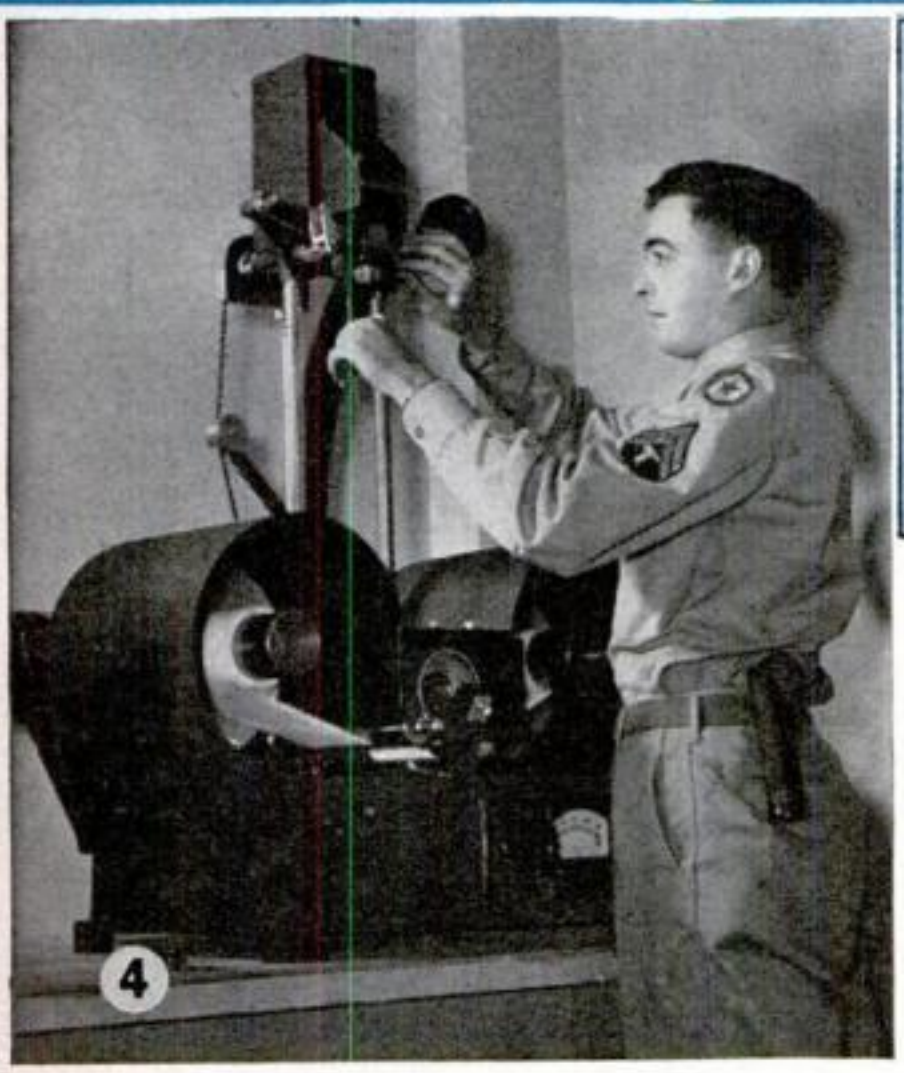


MAILBAG

printed and enlarged back to four by five-inch size. Having priority over all other types of personal mail, V-mail letters, which cost the sender only three cents postage, and are flown to their destination from the nearest point of embarkation, have been known to arrive from Australia in eight days; from England in six. To insure the arrival of the microfilm, a copy is kept at the sending point until it is definitely known that the film has reached its destination. In the event the plane is lost, another film is made from the copy and forwarded. Out of millions of letters, not one has been lost.

A technical sergeant inspects strip of processed microfilm

. . . Destination, Enlarged Back to Reading Size, and Distributed



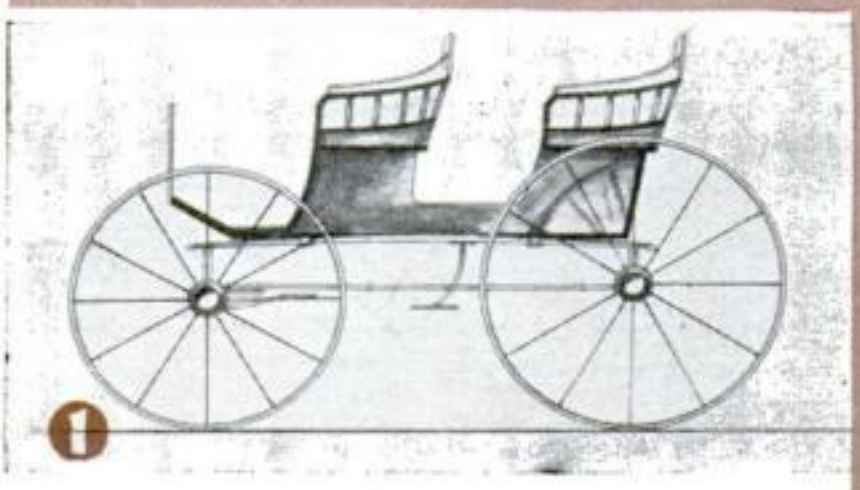
4 Having arrived at its destination, the film is placed in the printing machine, at left, which enlarges each of the film's images eight times

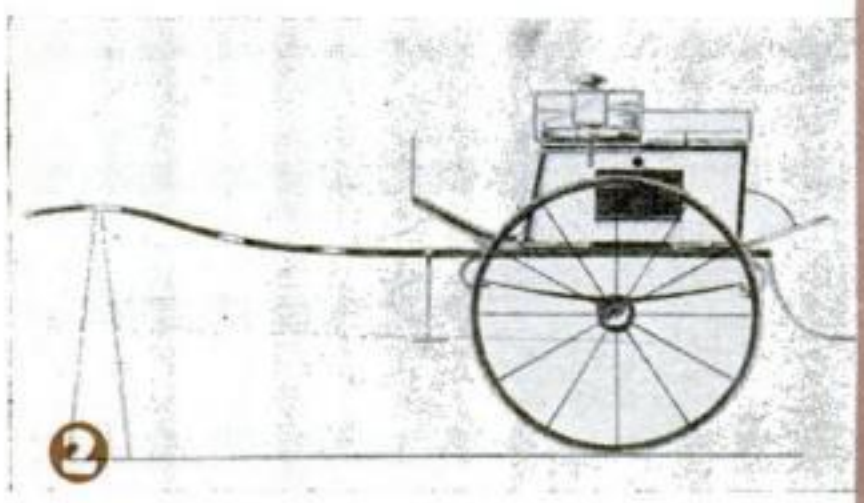
5 The paper-processing machine, lower left, handles three 825-foot rolls, develops each at five feet a minute. Rotary drier is in lower right of picture

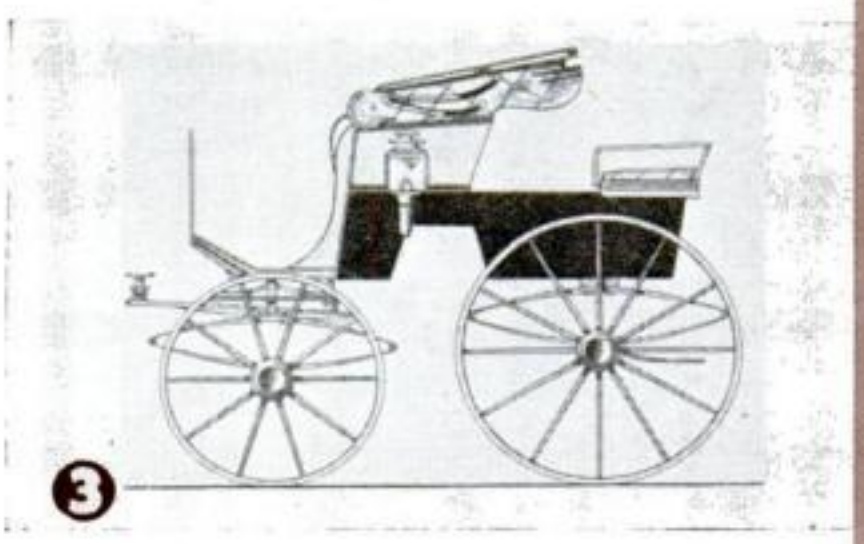
6 After enlargements have been developed and dried they are taken in strip form to the cutting room where they are separated and sorted for delivery

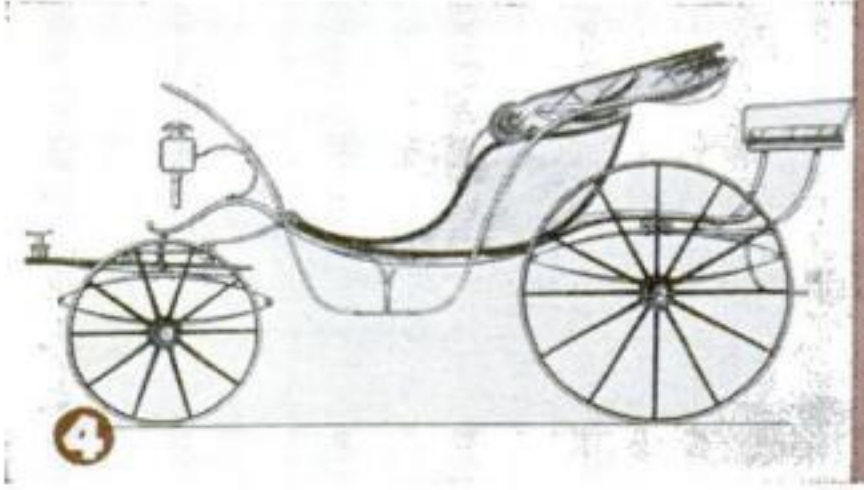
Question Bee

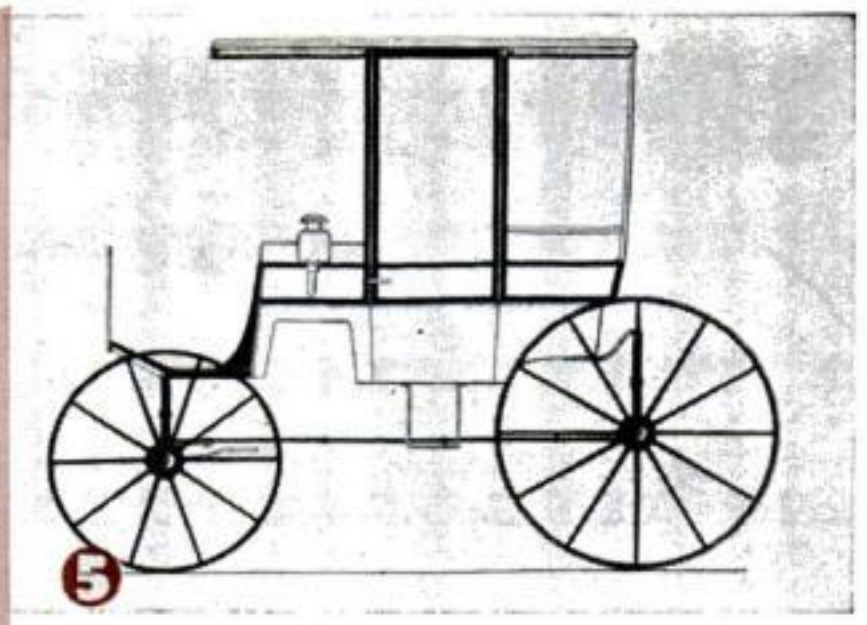
GAS and tire shortages are bringing back some of these eight American carriages, selected for POPULAR SCIENCE MONTHLY by William Brewster, famous carriage maker, from his prints at the Metropolitan Museum of Art. These are a buggy, brougham, phaeton (lady's), stanhope phaeton (gentleman's), station wagon, surrey, tandem cart, and victoria. Try to identify them, then see list below.

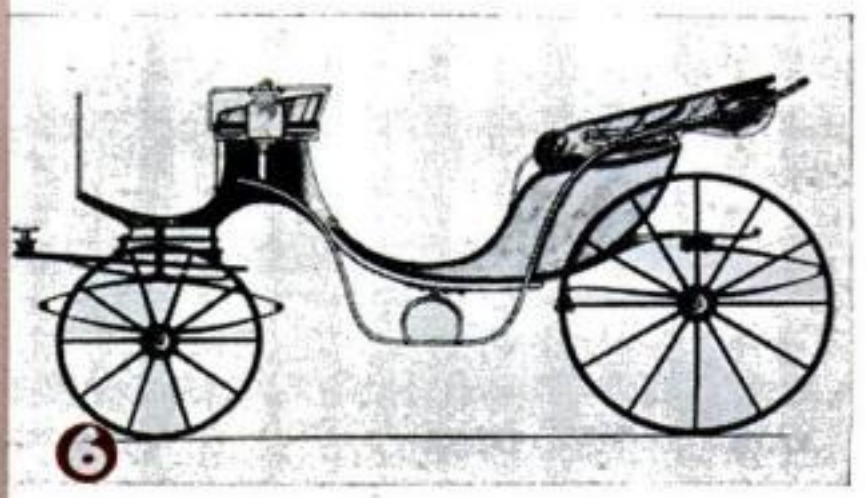


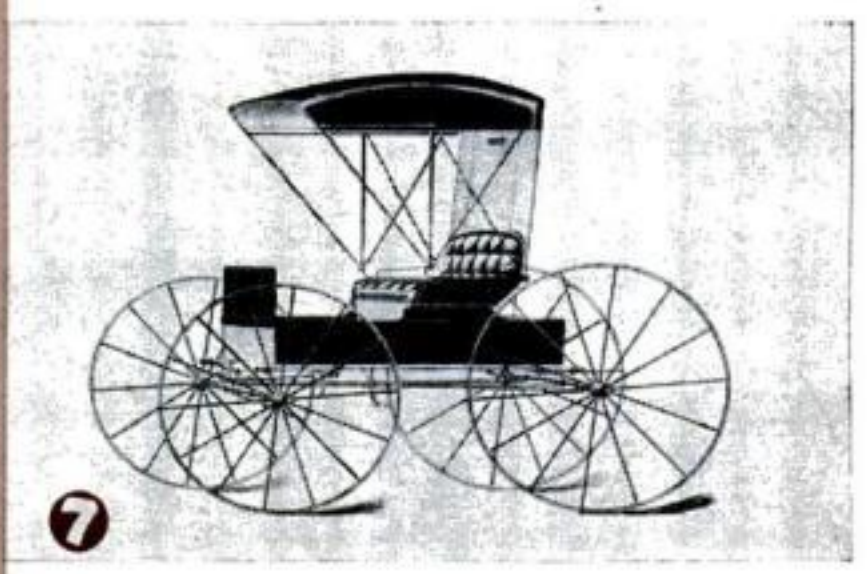


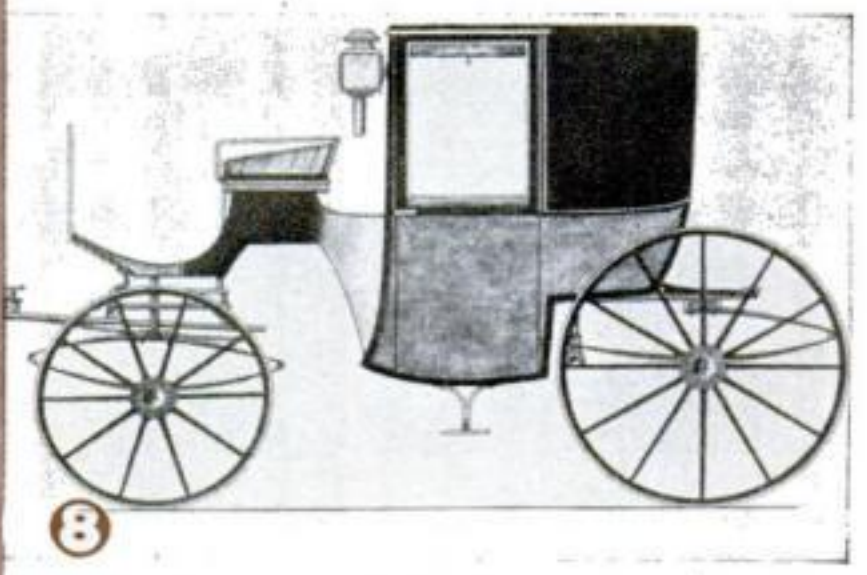












ANSWERS

1. Surrey.
2. Tandem cart.
3. Stanhope phaeton (gentleman's).
4. Phaeton (lady's).
5. Station wagon
6. Victoria.
7. Buggy.
8. Brougham.

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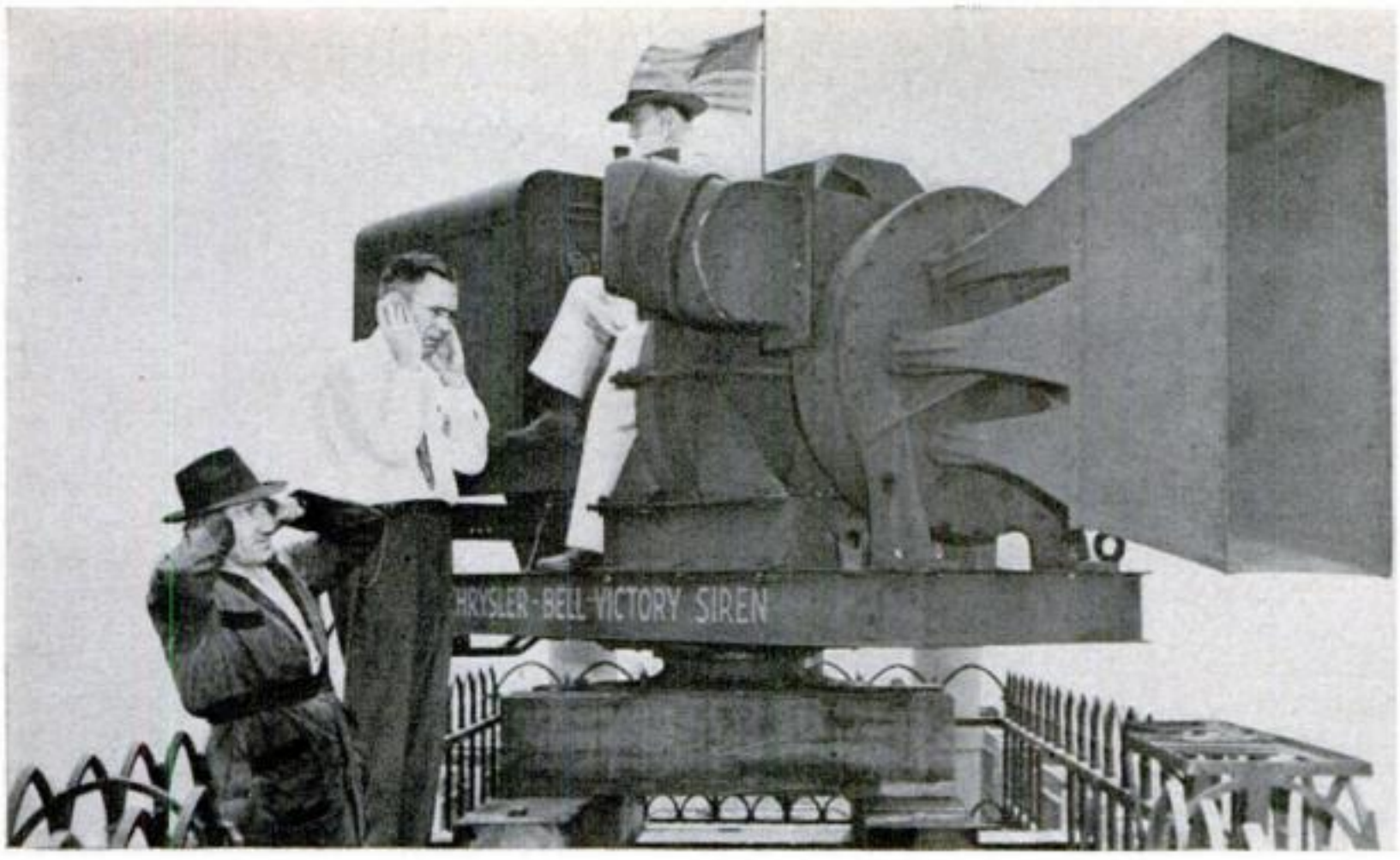
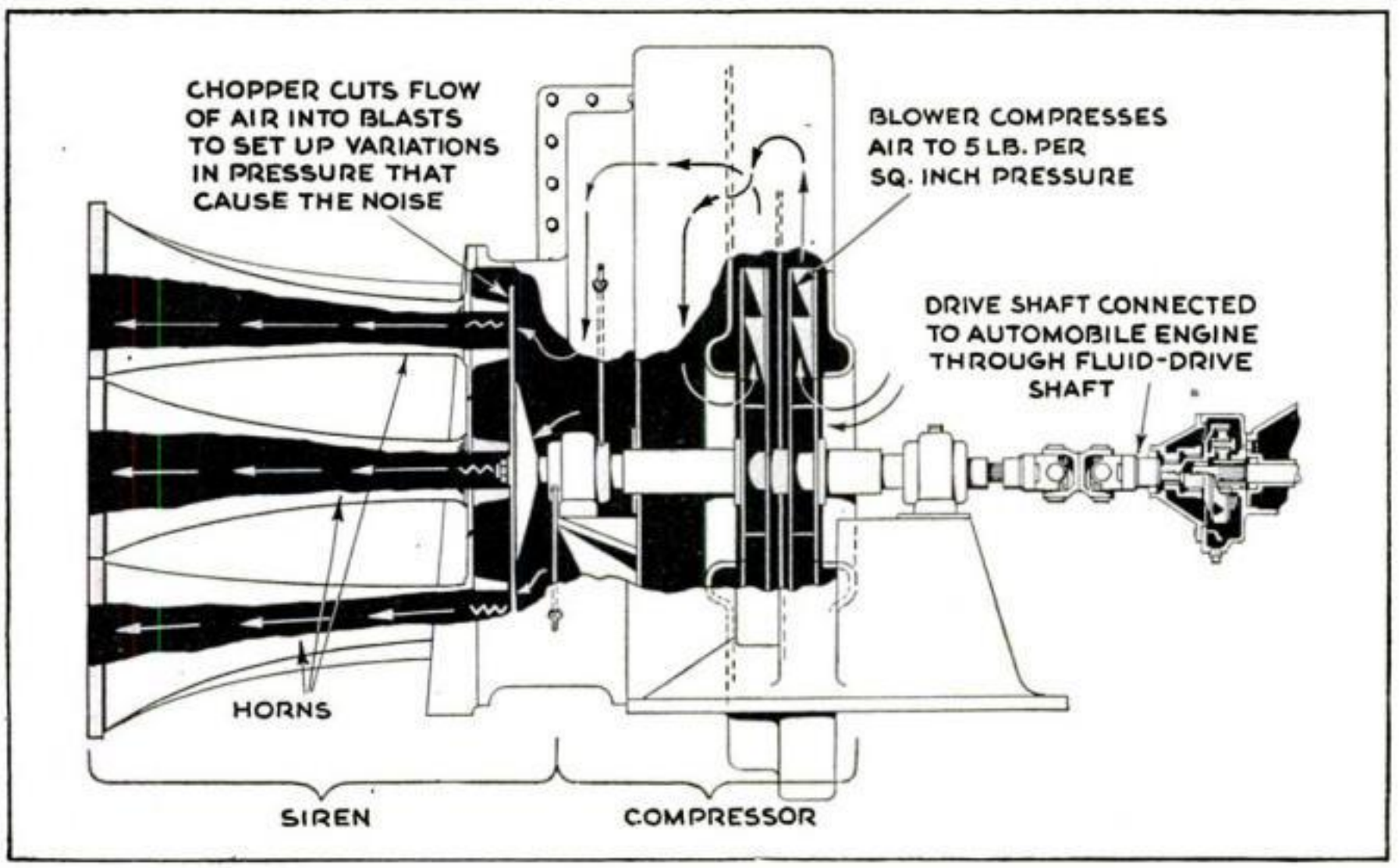


Testing the machine, engineers have to hold their ears as the siren blasts out its mighty roar over New York

New York Air-Raid Siren Nears Top Limit on Noise

SCIENTISTS have estimated that the loudest sound that could be produced would not reach more than 190 decibels. New York's super air-raid siren atop the RCA Building, when operating at full throttle, reaches a horn volume of 170 decibels, and can be heard over 50 miles away. The revolving mammoth "howler" comprising the siren proper, a blower to supply compressed air, and a 140-hp. engine to drive both, creates its ear-shattering roar by a high-frequency air disturbance. A "chopper," 25 inches in diameter, revolves behind six "throats" leading to the horn. As compressed air is sent into the throats at the rate of 2,500 cubic feet a minute, it is sliced off by the blades of the chopper, which revolves at a rate of 4,400 r.p.m.



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Pellets of Power

ELECTRONS, NATURE'S FUNDAMENTAL BUILDING BLOCKS, ARE WORKING NEW MIRACLES IN SCIENCE AND INDUSTRY

By HERBERT ASBURY

AN ELECTRON is a subatomic particle of negative electricity so small that a billion billion billion would weigh less than an ounce. Singly, its power is insignificant; more than two million million million electrons must pass a given point in the filament of a 100-watt lamp each second in order to heat the lamp to normal brightness. But assembled in countless multitudes, the electron becomes a giant of energy. Uncontrolled, it can produce a lightning bolt. Harnessed and controlled by the vacuum tube, in which electrons are pulled from atoms as corn is shelled from the cob, these tiny entities can exert forces powerful enough to drive battleships and run steel mills. At the same time they can be used to control the most delicate of operations.

Physicists and engineers believe that ultimately the electron will prove of greater value to mankind than any scientific discovery since the steam engine. They confidently predict the coming of an "electronic age," in which man's increasing knowledge and widening application of electronic energies will add immeasurably to his comfort, security and prosperity. "Electronics will become the bright new word of the future," Dr. W. R. G. Baker, well-known engineer of the General Electric Company, said recently. "It promises new and higher standards of living. It is almost universal in its potential application to our lives. The electronic tube will touch you, in the years to come, wherever and however you live and work—your sight, hearing, and taste; the food you eat, the healing of your body, the safety of your home, and the progress of your business."

Research in electronics has been so stimulated by the war and its pressing problems that physicists have probably accomplished more since Pearl Harbor than during the five years which preceded the Japanese attack. Many new discoveries and devices, the details of which are now military secrets, will be immediately applicable to industry when the world is again at peace.

Although the scientist conveniently describes the electron as a particle of electricity, actually he doesn't know what it is. If he did, he would know what electricity and matter are, and perhaps be able to solve the ultimate mystery of the universe. He has never seen an electron, and never will see one; it is smaller than a light wave and hence forever invisible. But since the English physicist Sir J. J. Thomson discovered in 1897 that electricity consisted of countless charged particles, science has learned to produce electrons at will, to control them, and to put them to work. The mass of the electron has even been established. Dr. Robert A. Millikan, of cosmic-ray fame, succeeded in 1910 in measuring the charge of a single electron, and from the data obtained in his experiments the mass of an electron was determined to be 1/1,835 part of the mass of an atom of hydrogen, the lightest atom known. In simpler terms, the electron, as far as weight and mass are concerned, is to an ordinary hen's feather as the feather is to the earth. But when an electron is set in motion it becomes heavier; the mass of the particle increases according to the speed at which it travels. At about 160,000 miles a second, the mass has doubled; and at the speed of light, 186,000 miles a second, it has increased sevenfold.

Extensive research during the past decade has identified the electron as a fundamental building block of nature, one of the three basic materials of which all matter is formed. The others are the proton, which carries a positive electrical charge, and the neutron, which has no charge. An atom comes into existence when protons and neutrons assemble to form a core, or nucleus, and attract electrons, which travel around the core in an orbit the exact nature of which is still undetermined. The nature of the atom depends upon the number and arrangement of these basic particles. An atom of hydrogen, the simplest structure known, consists of one proton and one electron. An atom of helium has two electrons, an atom of lithium three, an atom of beryllium four, an atom of boron five, and so on down the list of chemical ele-

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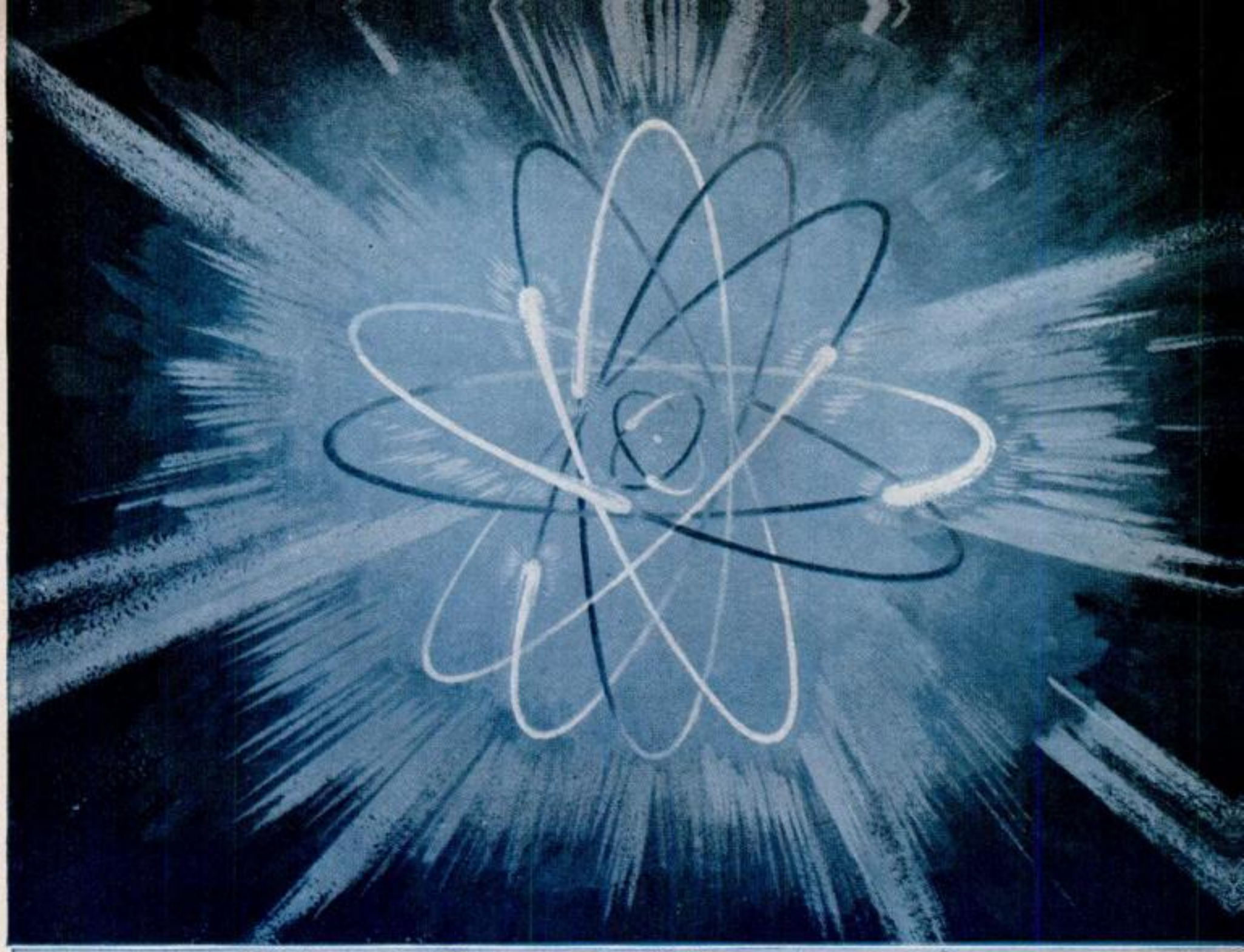


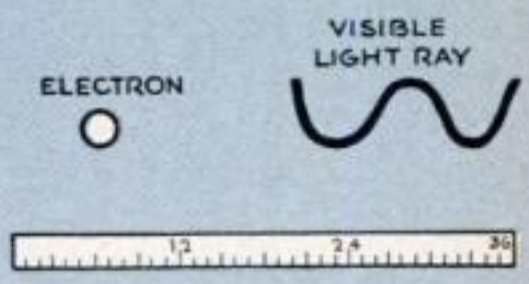
What Is an Electron?

It Has Speed

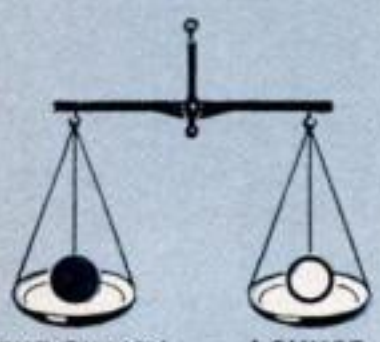
More than two million million million pass a given point in the filament of a 100-watt lamp in one second

It Has Size

Since an electron is smaller than a light wave of the visible spectrum, it cannot be seen by the human eye



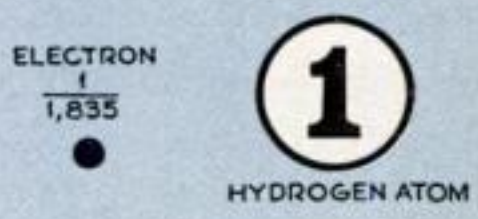
It Has Weight



If you could put a billion billion billion of them in the scales, they would weigh less than an ounce, they are so inconceivably small

It Has Mass

Its mass is 1/1,835 that of an atom of hydrogen. In other terms, it is to an ordinary chicken's feather as the feather is to the earth



ELECTRONS are almost unimaginably small particles of negative electricity. Along with protons, which are positively charged, and neutrons, which carry no charge, they make up the atoms of which the whole universe is composed. The diagram at the top of the page is a physicist's conception of an oxygen atom. Its nucleus is a cluster of eight protons and eight neutrons. Whirling around the nucleus, like planets around the sun in our solar system, are eight electrons. The space between the nucleus and the electrons is empty except for the energy that keeps the system in balance.

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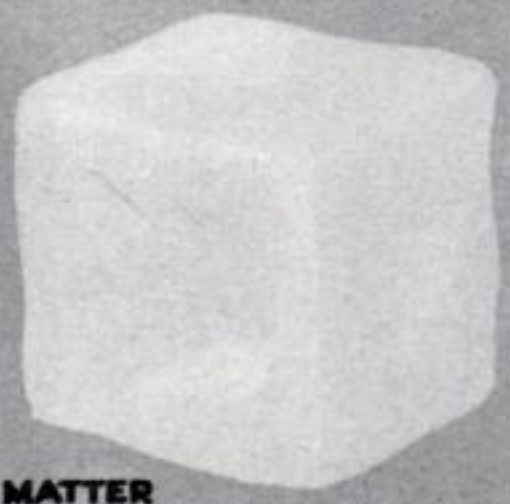
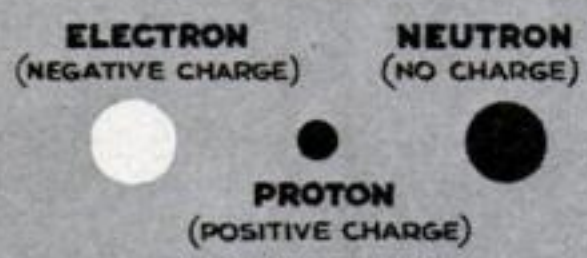
MATTER IS MADE OF ELECTRONS, PROTONS, AND NEUTRONS

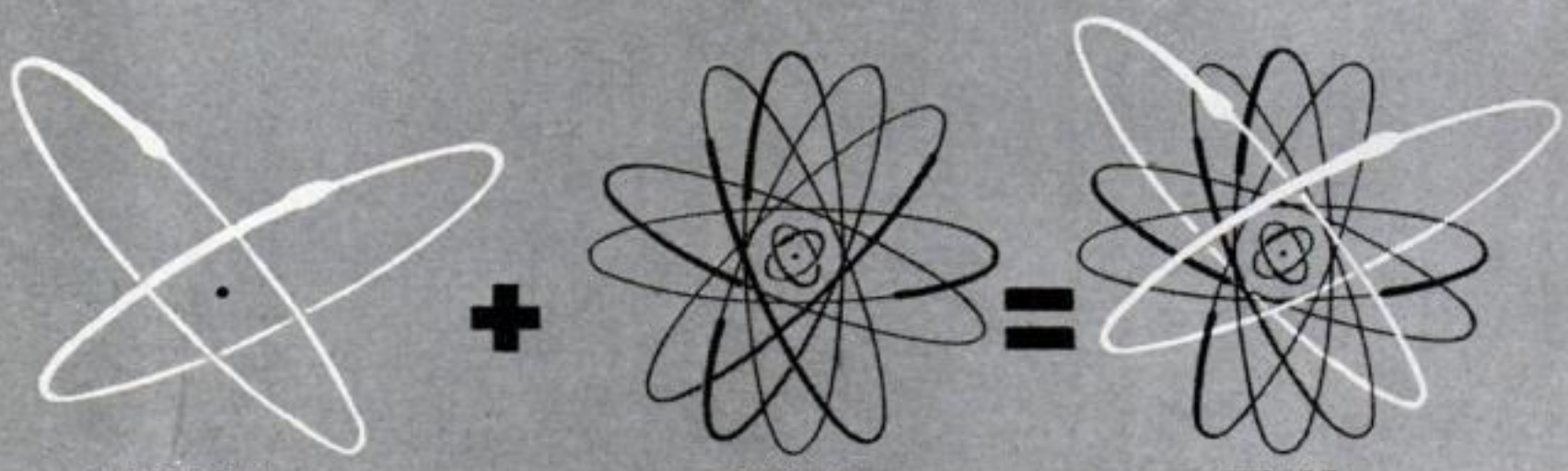


MATTER



MATTER, in all of the many forms in which we know it, is formed from these three fundamental particles in various combinations. Elements differ only in their number and arrangement in atoms

HOW ELECTRONS FORM CHEMICAL BONDS BETWEEN ATOMS



What happens when two atoms of hydrogen combine with one atom of oxygen to form a molecule of water. In the compound, the one electron of each hydrogen atom spins in an orbit around its own nucleus and the oxygen's

ments to uranium, which has 92. All electrons are alike, regardless of what the atom may be; atoms of gold, lead, steel, and oxygen give off identical electrons.

Some elements part with their electrons more freely than others, and are consequently more suitable for use in vacuum tubes. It is difficult, for example, to strip an electron from an atom of mercury, but an atom of the metal cesium will yield one of its 55 electrons with scarcely a struggle. The metallic element thorium is even more generous. When a vacuum-tube filament was made of tungsten combined with one percent of thorium oxide, physicists found that it produced up to 100,000 times as many electrons as tungsten alone. In these tubes the electrons come from a layer of thorium metal one molecule thick, formed from the thorium oxide diffusing to the surface of the tungsten filament. This discovery resulted in the development of new vacuum tubes which lasted longer and required less power to operate.

Protons and electrons are equally though oppositely charged, and in normal circumstances the atom has precisely the right number of electrons to neutralize the positive charge of the protons in the core and maintain it in a state of equilibrium. But if one or more of the electrons are dislodged this delicate balance of forces is disturbed, and the atom attempts to restore it by attracting free electrons. When you stroke the back of a cat you are scraping electrons from the surface atoms of the animal's fur. Sometimes when you do this your hand tingles and you "get electricity." What you feel is the electric current, or path of ionization, set up by swarms of electrons rushing to the cat to restore the atoms of the fur to equilibrium. The same thing happens when you rub your feet on a thick-pile carpet or rug and then grasp the knob of a door. You have stirred up a miniature thunderbolt, for lightning itself is a similar manifestation on a gigantic scale—a path of ionization, strewn with atomic wreckage,

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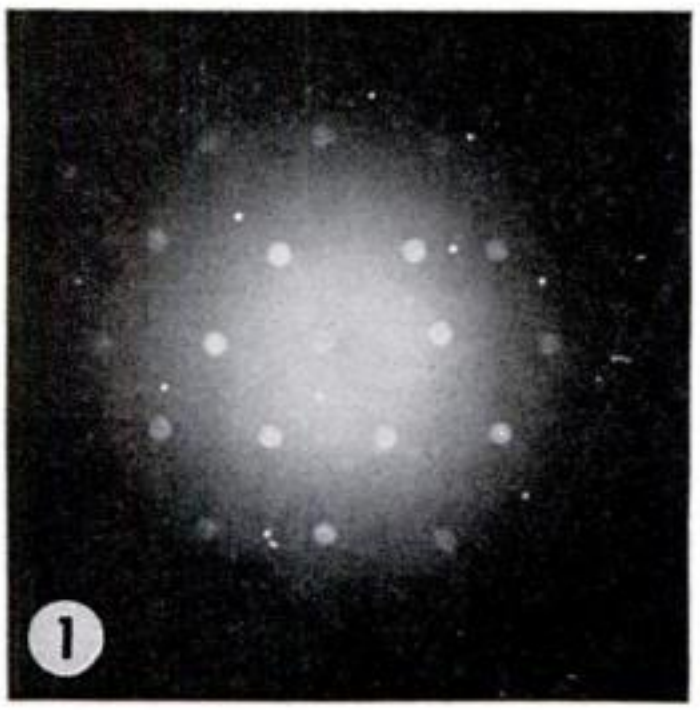
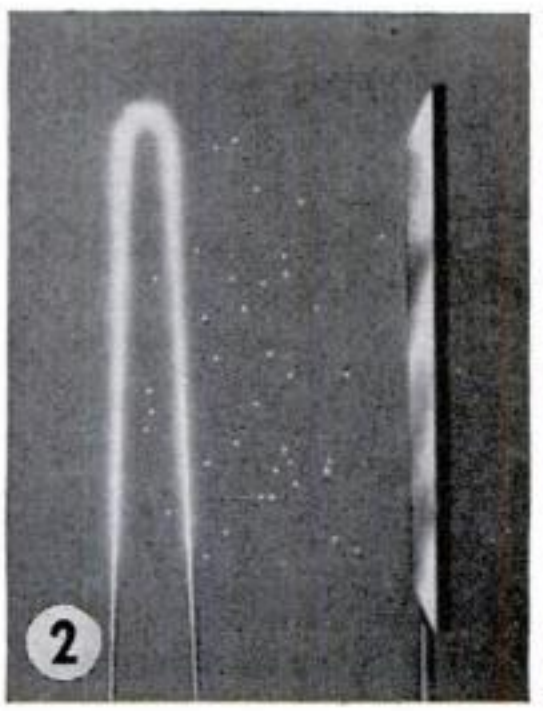
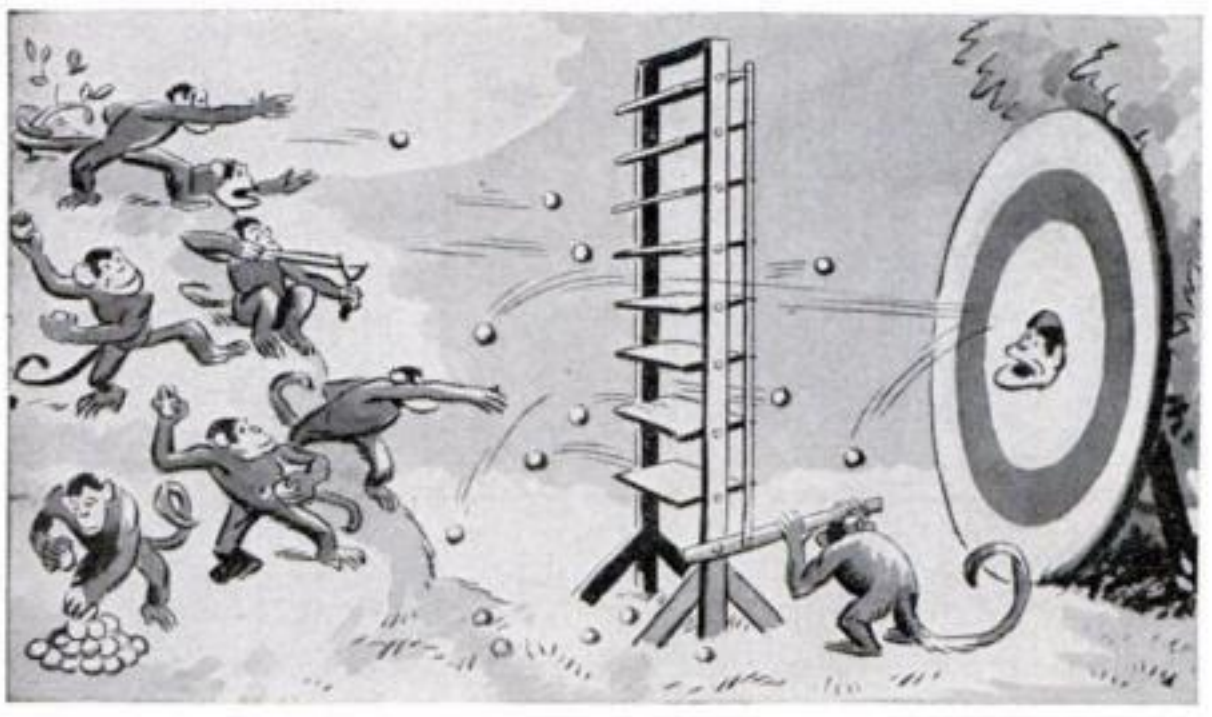
HOW ELECTRONS ARE PUT TO WORK IN A VACUUM TUBE





ELECTRONS (smaller dots,1) bump their way through molecules in a substance of low conductivity. In a two-element vacuum tube (2) they flow from the filament when the plate carries a positive charge. In a three-element tube (3) the grid makes it possible to control the flow between the filament and plate



GRID ACTS AS SHUTTER CONTROLLING THE FLOW

This bit of monkey business explains the function of the grid in a three-element tube. Coconuts (electrons) thrown by the monkeys (filament) at a target (plate) must pass through the shutter (grid). Their passage is speeded or retarded by the position of the shutter, which corresponds to the grid charge. In the case of simple radio reception this is governed by the nature of the incoming signal

made by the passage of countless electrons between two points of opposite charge. The ionization which the lightning accomplishes so noisily is constantly being done quietly by solar and other radiations. In consequence, the air is more or less filled with free electrons, and is continually undergoing electrical change. It is for this reason that an object charged with electricity will gradually lose its charge if exposed to the air. Free electrons are attracted to it, and in time restore it to electrical equilibrium.

Most metals will yield electrons freely, and for that reason are good conductors. But among gases the reverse is true. A gas atom clings to its electrons with great tenacity, and collision or other force is required to release them. A gas will not pass an electric current until it has been ionized. Copper is a superior conductor because one of the 29 electrons of a copper atom is a vagrant, so lightly held that it can, and does, roam almost at will among the other atoms. It is the movement of these electrons that constitutes a current of electricity. The speed of the current through a copper wire seldom exceeds eight inches a minute, but changes of the current produce an electromagnetic field, through which tremendous energy in the form of electromagnetic waves hurtles at the velocity of light.

Physicists explain the huge energies obtained by the enormous number of particles taking part. A General Electric scientist, Dr. A. W. Hull, has calculated that the number of vagrant electrons in a cubic inch of copper wire is 15×10^{23}—ten followed by 23 ciphers. Another physicist has computed that the number of drops of water which flow over Niagara Falls in a hundred years is about equal to the number of electrons which pass through the filament of an electric lamp in one minute. Similarly inconceivable numbers of electrons are freed by vacuum tubes. Each square inch of filament in a radio tube, for example,

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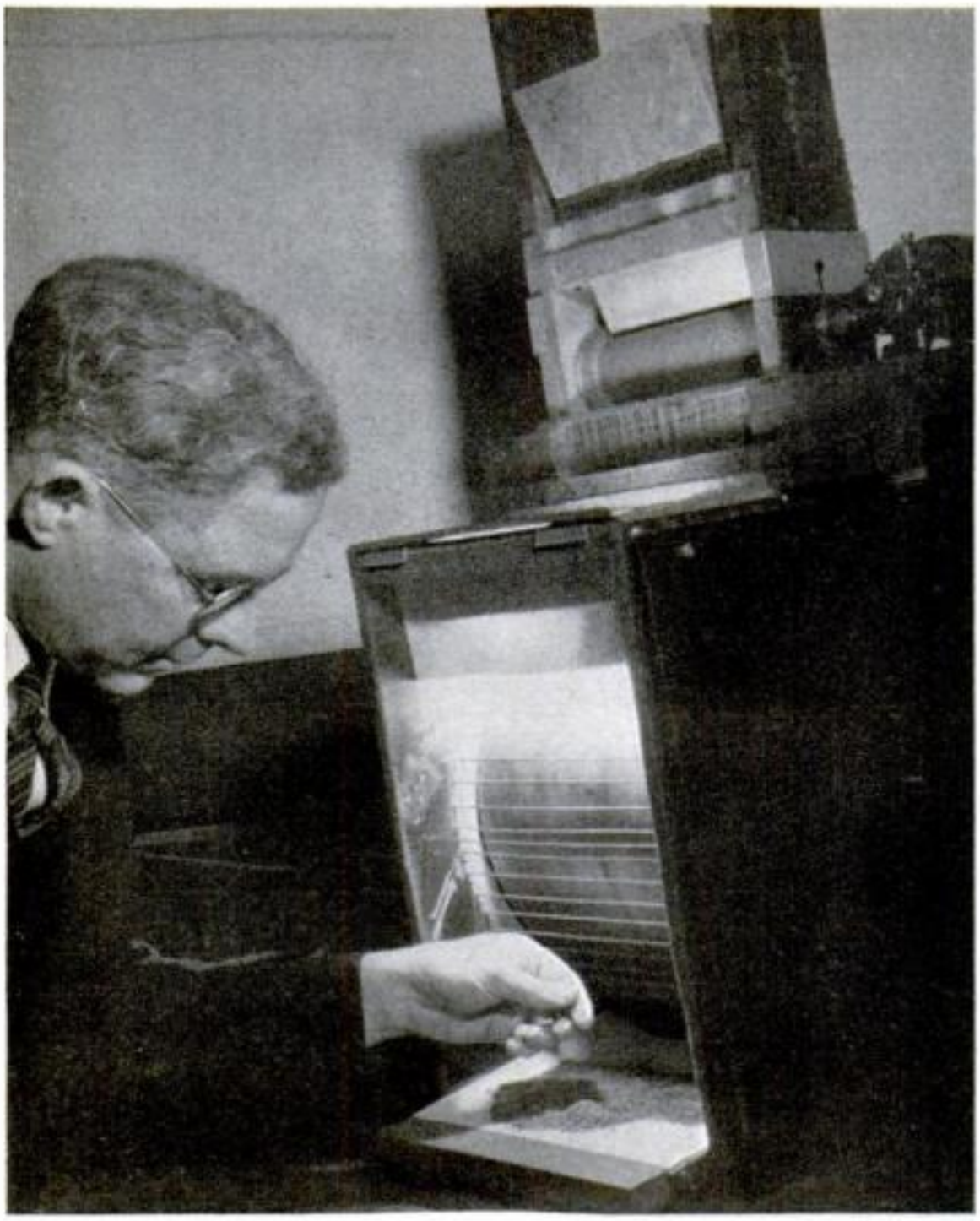
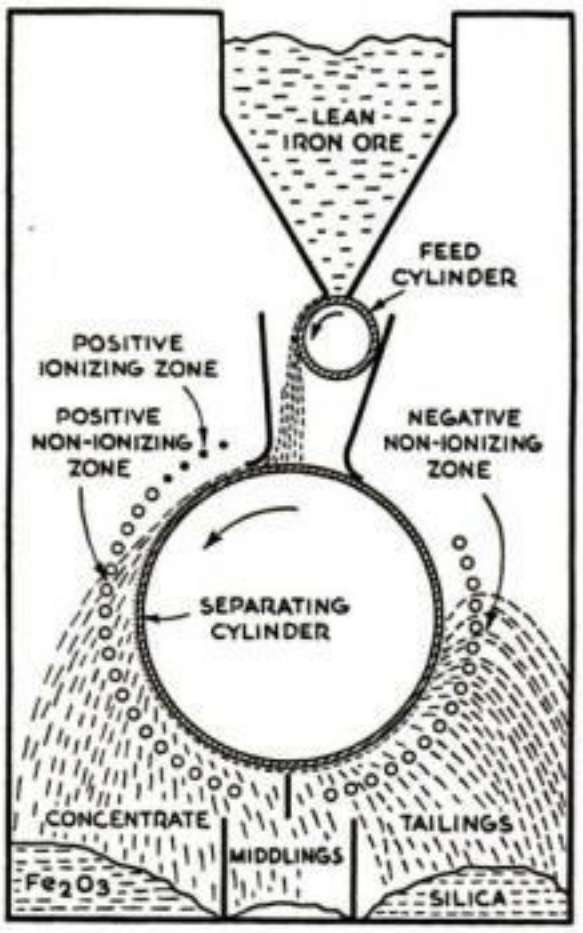


ORE SEPARATOR. Valuable metals may be extracted from low-grade ores by electrical machines like the experimental model seen at the left, developed at Westinghouse Research Laboratories. Finely ground ore poured into a hopper at the top trickles onto a rotating drum where it is held by electrical charges. The metal particles lose their charge and fall off; the sand is removed at the back by charged wires



releases more than ten billion electrons every second.

Electrons may be stripped from their atoms by the application of various forces, such as chemical action, pressure of an electric circuit, collision with high-speed particles, heat, light, and friction. The simplest way is to heat a filament of tungsten, or some other metal of comparable toughness, in a vacuum until electrons pour from it like steam arising from boiling water. That is what happens in an ordinary electric lamp when you switch on the light: the hot filament emits electrons in untold numbers.

But while these and other forces can free the electron, it can be controlled and really put to work only by the vacuum tube, which has come a long way since Thomas A. Edison made one in 1883, 14 years before the electron was trapped and identified by Sir J. J. Thomson. Edison's tube was simply an electric light bulb into which he had sealed an extra wire. By charging this wire with positive electricity, Edison succeeded in pulling a current through the vacuum of the bulb. His discovery was improved upon by Professor J. A. Fleming and others, and was utilized to some extent by Marconi in the development of wireless telegraphy. But its commercial possibilities were not recognized until Dr. Lee de Forest, in 1906, devised the grid, a wire mesh which, when charged, gave him greater control over the current flowing through the tube. The development of modern electronics, however, did not begin until Dr. Irving Langmuir of the General Electric Research Laboratory, in 1913, announced his discovery that electrons would not only flow better in a vacuum than in a "soft" gas-filled or partial-vacuum tube, but could actually be controlled there with predictable results.

Today, vastly improved and embodying many new principles, vacuum tubes are made for many special purposes and in a great variety of sizes, from the small detector tubes to the giants used to produce electrical oscillations for radio-telephony. One of these huge tubes can handle enough power to supply 75 homes, and up to 100 gallons of water a minute are required to cool the metal plates. Regardless of size, all vacuum tubes must have at least two elements, a negative electron-emitting cathode,

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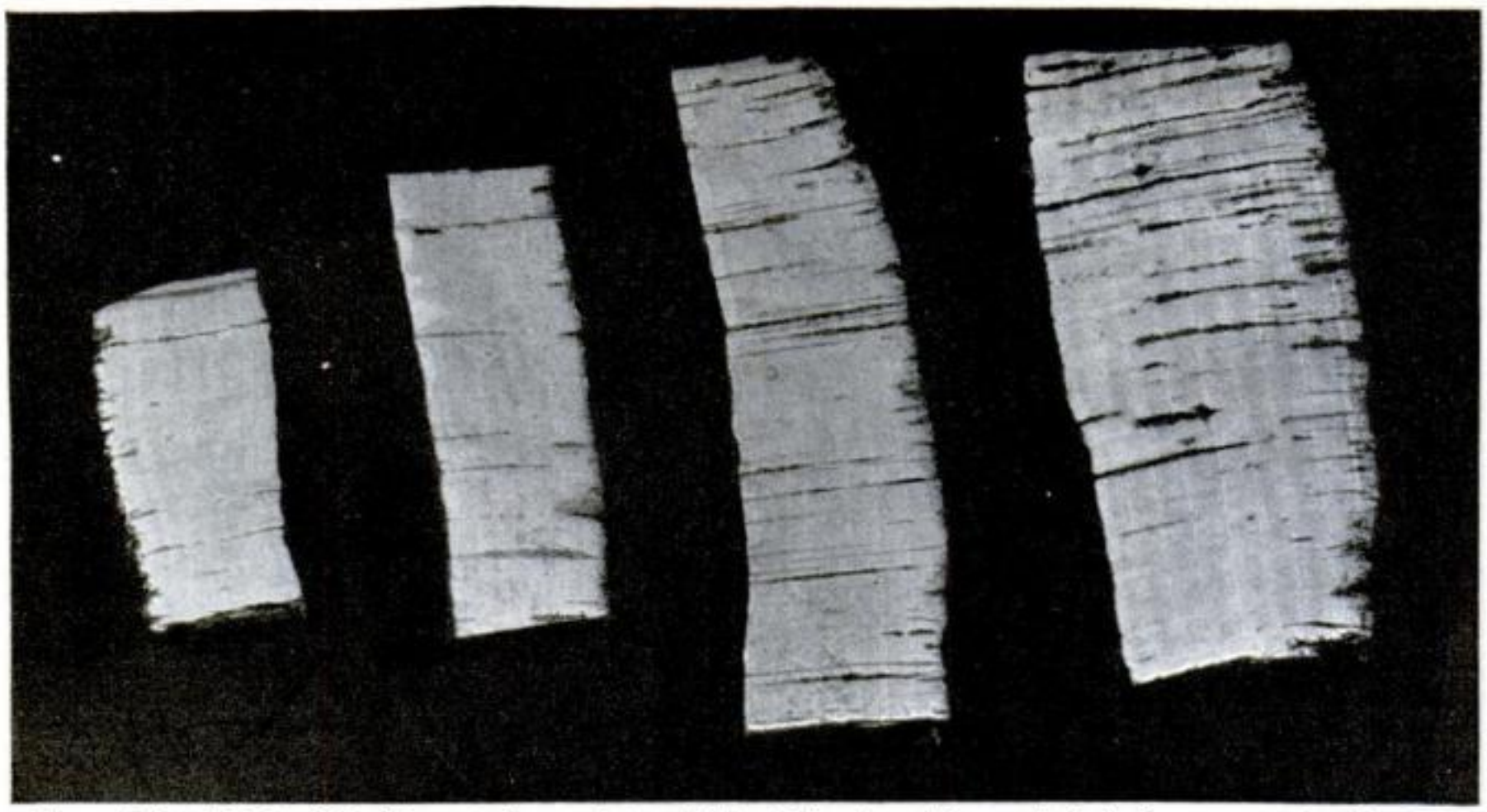
and a positive anode, which pulls the electrons across the vacuum. Tubes depend for operation upon the emission of electrons from the cathode, whence they are driven out by heat or light. Since the electrons are negative, they rush for the anode, setting up a current which is passed out of the tube over external wires. In tubes which are to be used with high-voltage electricity a very "hard" vacuum is needed; that is, air must be pumped out until less than one molecule remains out of every original hundred million. This causes the electrons to overcrowd near the cathode and set up a negative condition which permits only a little current to flow.

The third element, the grid, which is used in some vacuum tubes, is introduced between the cathode and the anode. It can be made negative, neutral, or positive, and by regulating its potential the flow of current in high-vacuum tubes can be started, stopped, or modulated at any time. In vapor or gas-filled tubes the avalanche of electrons is so strong that once it is started the grid can do nothing. But it can take control at zero potential on the anode, and not let the flow start until it is ready. By this means the current can be regulated.

The most important use for electronic tubes at present is in control devices, where their high sensitivity, instantaneous action, and limited output are employed to actuate other devices. They have affected our lives to a much greater extent than the average man realizes, for they have provided engineers with the means to do better many things that were being done, and enabled them to do things that were impossible before tubes became available. Four great industries upon which we rely for communication and entertainment—radio, telephone, moving pictures, and phonograph—all depend on the electronic tube.

SCANNING ELECTRON MICROSCOPE. Combining the principles of television, the electron microscope, and facsimile radio, this new electronic instrument developed in the RCA Laboratories makes tremendously magnified photographs of opaque surfaces just as the ordinary electron microscope does of transparent specimens. At the left is a picture of etched brass made with it



Four of the 100 to 150 different classes into which stripped cork is graded before processing begins. This is an important part of cork manufacturing. Badly cracked strips are ground for composition cork

Stopping a Bottleneck

By JEAN ACKERMANN

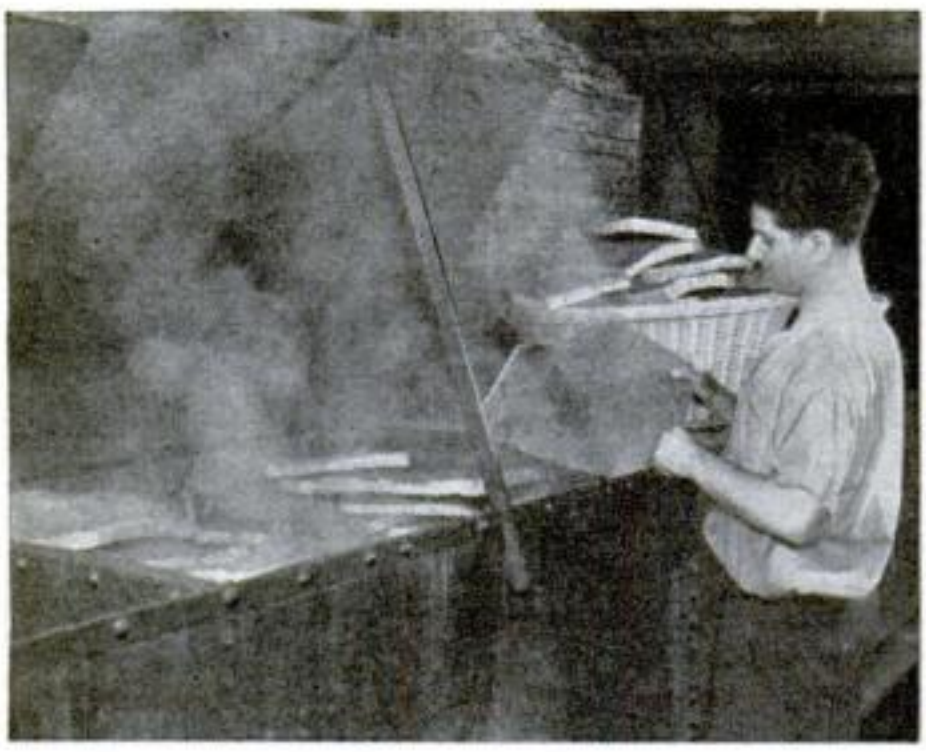
"THERE'S enough cork for two to five years, with more still coming in on neutral ships; no need to worry yet."

That's what the cork experts say, but in times like these "enough" has a special meaning. There isn't enough for unlimited civilian use. There will be enough for essential purposes, and the development of alternative materials, plus expert use of the existing stockpile, will close the gap.

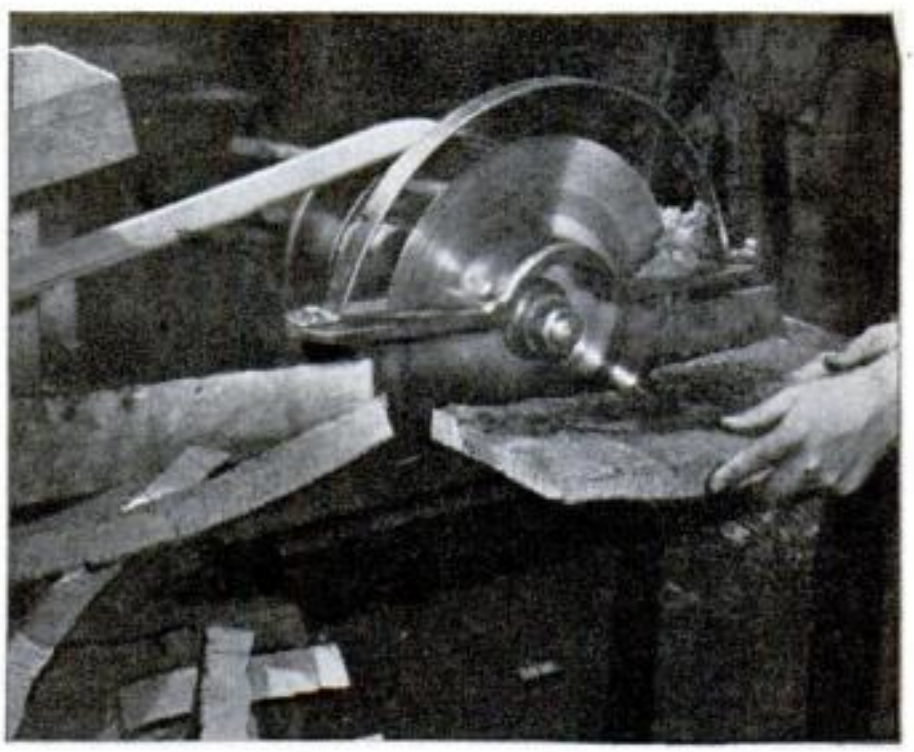
Cork goes to war, on land and sea and in the air. Some of its commonest uses are for temperature and sound insulation, life preservers, ammunition plugs, gas-tank floats, seals, gaskets, and washers. To help provide these, more linoleum is now being made without cork, and the cap on your soft-drink bottle is lined with paper.

Cork, to the average American, probably means bottle stoppers and fishing floats. Actually, specialties of this type accounted for only three percent of U. S. consumption

1 Slabs of cork are steamed at the factory as the first step in manufacture. This softens the cork, making it more workable



2 When bottle stoppers are to be made, a keen knife cuts the cork into fillets or strips. Stoppers are cut from them across the grain



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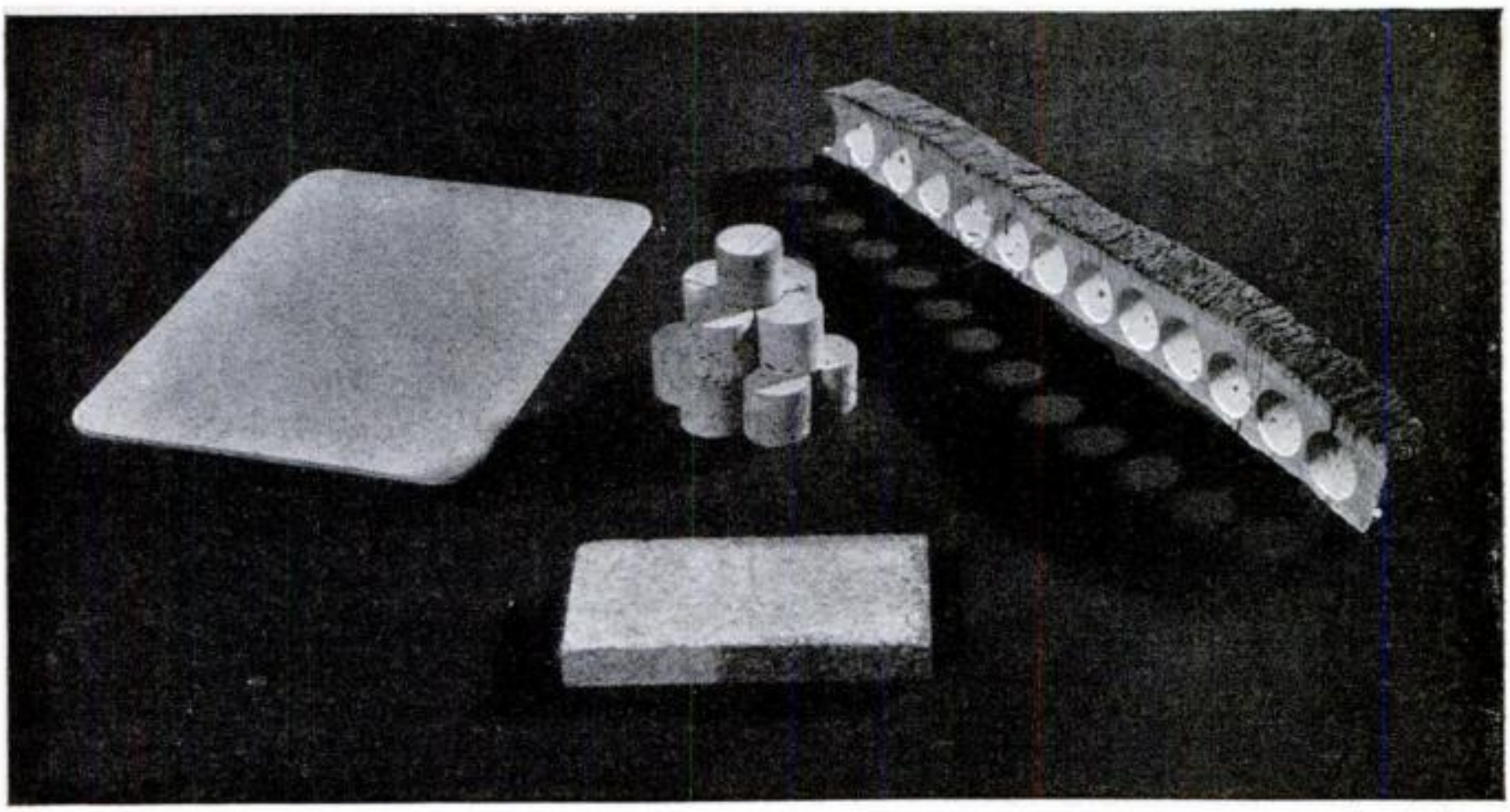

Here is the cork industry in miniature. First, stoppers are punched, then the "waste" granulated for compressing into insulation board (foreground) or conversion into composition cork (the mat at left)

NEW MATERIALS, PLUS ECONOMICAL USE, EKE OUT OUR SUPPLY OF IMPORTED CORK

of cork in normal times. Insulation board was the chief product, using 60 percent, composition cork (gaskets, washers, and novelty items like buttons and table mats) took 27 percent, and 10 percent went into linoleum.

Now insulation products are held to 30 percent of their former output, and this is allocated for war use. Cork is virtually barred in linoleum, vibration mats, shoe soles, road expansion joints; and completely so in fishing bobbers, shuttlecocks, table coverings, fishing-rod handles, and pen-holder grips.

Cork stoppers for chemicals and medicines can still be made up to 80 percent of the normal quota. The best-grade natural cork from which they are made is too costly for insulation. Some bottlers, however, are already testing a plan for piecing out the supply by making stoppers with a thin curl of cork around a wooden core.

Production of crown bottle caps with composition-cork linings has been held to

3 "Blocking" with a circular knife cuts out the stoppers—by hand, as below, or by automatic blockers which are costly and cause more waste

4 After tapering, bleaching, and sterilizing, stoppers are sorted into 10 grades. A good worker can classify up to 35,000 corks a day

Factory pictures courtesy of Liberty Cork Co., Jersey City, N. J., and Bloomingdale Mfg. Co., Butler, N. J.

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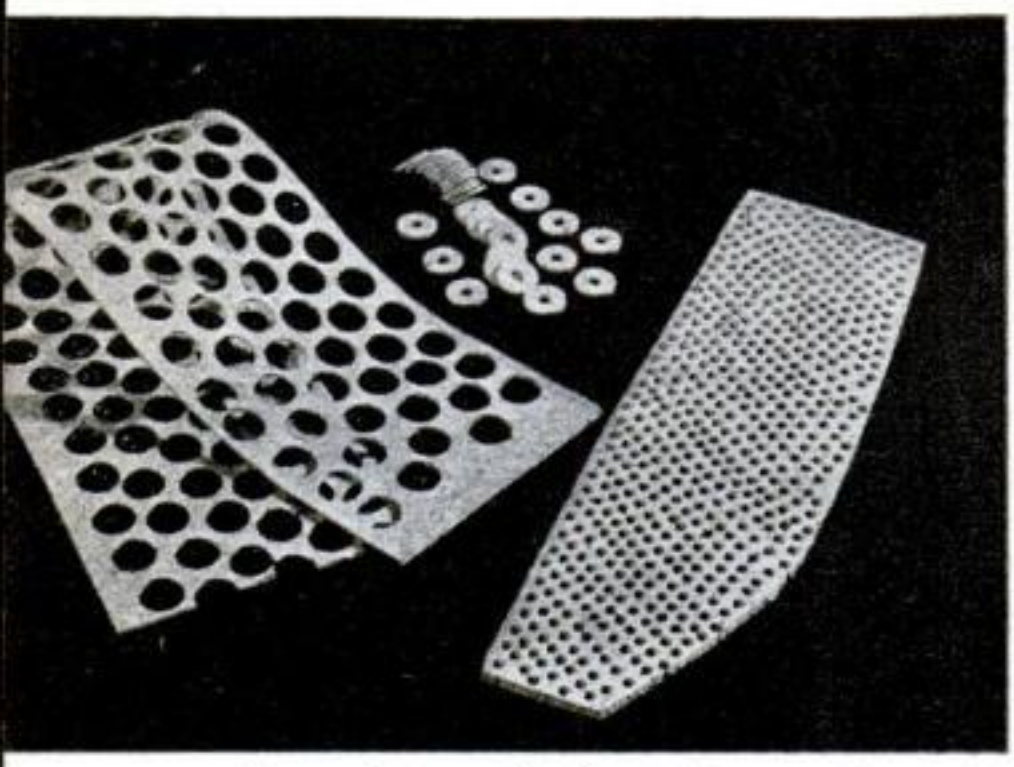
5 Stages in processing a stopper. Here the sides are tapered, and the shaving used on the pouring top at right. A smaller stopper is next cut out, and the cork ring fitted with a top and dauber

70 percent, and is being slashed again. Manufacturers have been using thinner disks, and are experimenting with paper board covered with Pliofilm, and with narrow cork rings circling centers of vinyl or some other plastic. If extreme need arises some are understood to be ready to reclaim and reprocess used cork and cork linings. There are difficulties in the way of this, since the granular nature of composition cork makes it hard to sterilize.

For heavier industrial uses, a number of replacement products have stepped up production. A mineral-wool insulator is made by treating rock or slag, mixed with coke, in a 2,000-degree furnace and then disintegrating it into tiny fibers with a jet of steam. This can be packed loosely into crevices, formed into a blanket, or pressed with an asphalt binder into slabs of "rock cork."

A newer process, which may become a

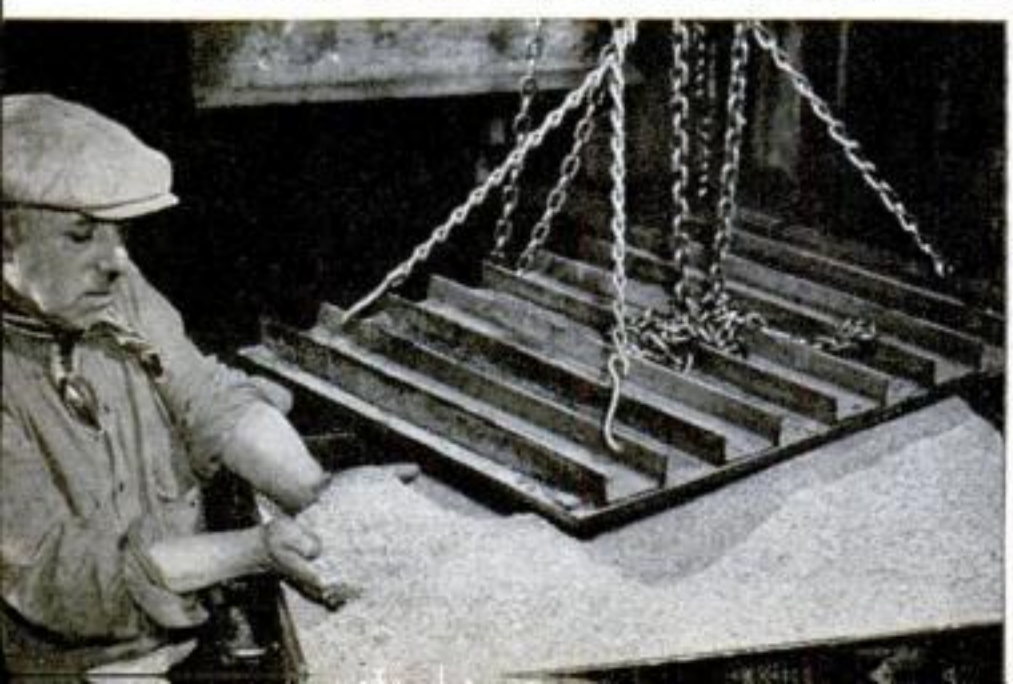


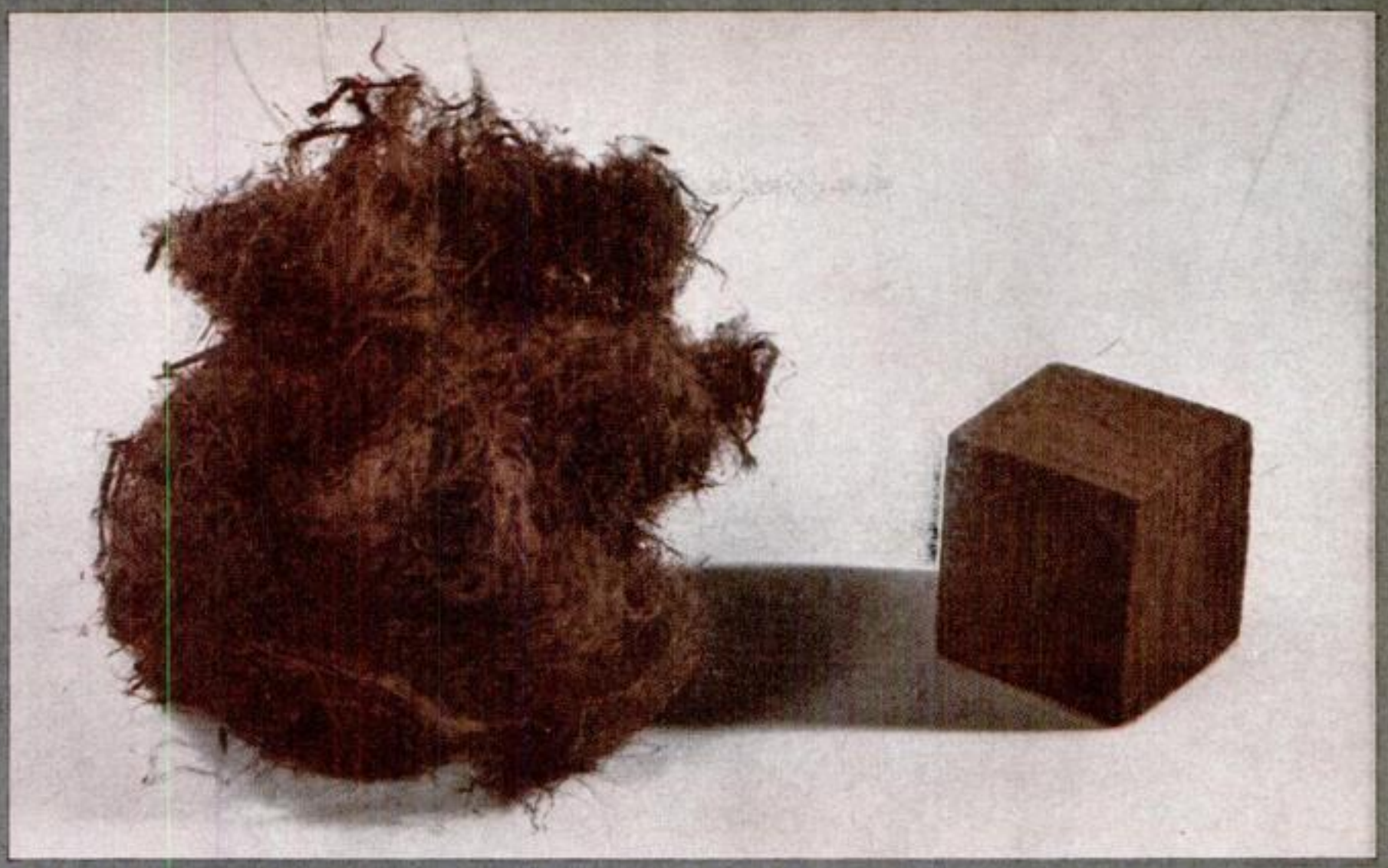
6 No cork is really lost. The raw "waste" at right, remaining after toothpaste caps are punched out, is ground with composition "waste," left, to make more gaskets like those at the top

7 More cork "waste"—chopped odds and ends ready to go into the granulating machine as the first step in making insulation cork board, floor mats, and other composition-cork articles

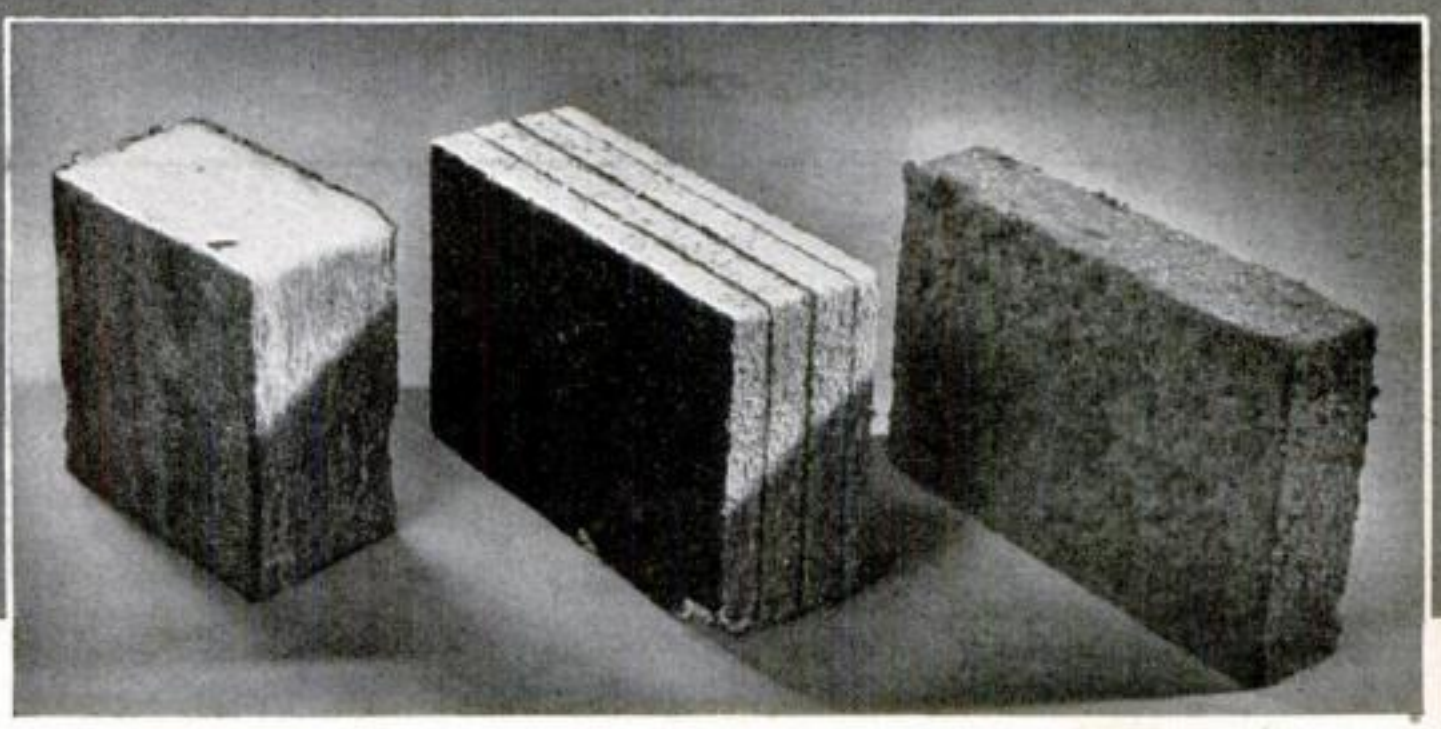
8 Granulated cork from "waste" and the inferior grades is put in metal molds and pressed into boards. Cork insulation has been so popular here that cork "waste" for making it is often imported

9 After compression in the molds, the blocks of granulated cork are baked solid in large ovens. Under heat and pressure, natural resins bind the cork granules in a tightly packed mass





SUBSTITUTES: Shredded bark of the American redwood tree is proving an excellent insulation material. It costs only a fourth as much as cork board, and may become a serious competitor of it after the war. Some of the shredded bark is shown above with a cube of the bark beside it



Glass fiber with an asphalt coat, sugar-cane fiber felted in layers with asphalt, and mineral wool bonded with an adhesive are all cold insulators

serious competitor of cork after the war, employs the shredded bark of the American redwood tree, and makes a good insulator at a quarter the cost.

Bagasse, or sugar-cane fiber, pressed into blocks, is another relatively new insulator, commercially called Celo-block. Although not as efficient or long-lasting as some materials, it is cheap, and is gaining so in popularity that shipments are a month behind orders.

Still in the test-tube stage, but promising, are "Nylon leather" and puffed-up sand. The "leather" is made from ground Nylon, melted under pressure of some inert gas like nitrogen or carbon dioxide. With controlled pressure, it can be made tough and leathery or porous and spongy. But now most Nylon is going into war fabrics.

Puffed-up sand (silica aerogel) is reported to be more resistant to heat than any other known substance. A light, opalescent, easily pulverized solid, it contains as much as 95 percent air by volume.

Glass occupies a special position in the insulation field. Glass wool, closely resembling mineral wool in its manufacturing process, is 40 percent lighter than cork. A new type of glass insulation in cellular form has appeared recently. This is called Foam-

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glas (P.S.M., Nov. '42, p. 49) and is made by forming glass into light, rigid blocks, enclosing tiny airtight cells.

Attempts are being made to start stands of cork trees in this country. There are a few in California, and plantings have been made in Arizona and New Mexico, but reports indicate that we have only about 2,000, not enough for even one percent of our needs. (Incidentally, the U. S. Department of Agriculture wants information on unreported cork trees so, if you know of any, notify your State Forester.)

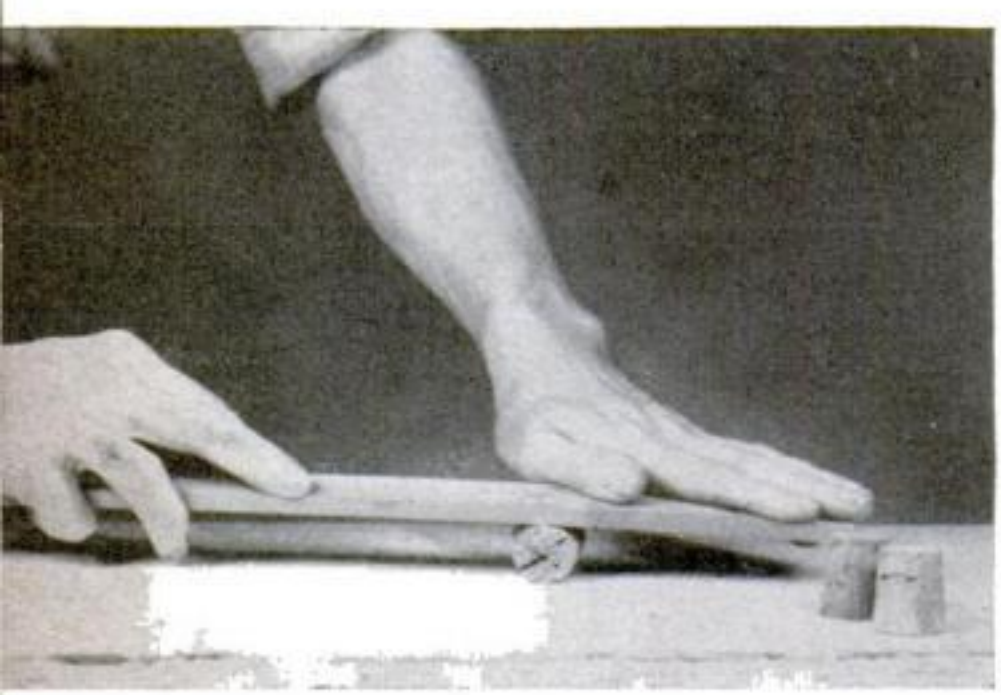
Several of our native fir trees have a corky bark. University of Washington scientists have extracted small quantities of cork bark from the plentiful Douglas fir, but there is no immediate commercial prospect.

True cork is the outer bark of the cork oak, *Quercus suber,* that grows mainly in Spain and Portugal, and to some extent in North Africa. The bark is a light, tough, resilient natural insulator. The tree flourishes where days are hot and nights cold, and has developed a thick, light outer covering for insulation. Trees in the United States frequently shed their bark before it is ready for use. Perhaps this is because of the absence of violent changes of temperature in our climate.

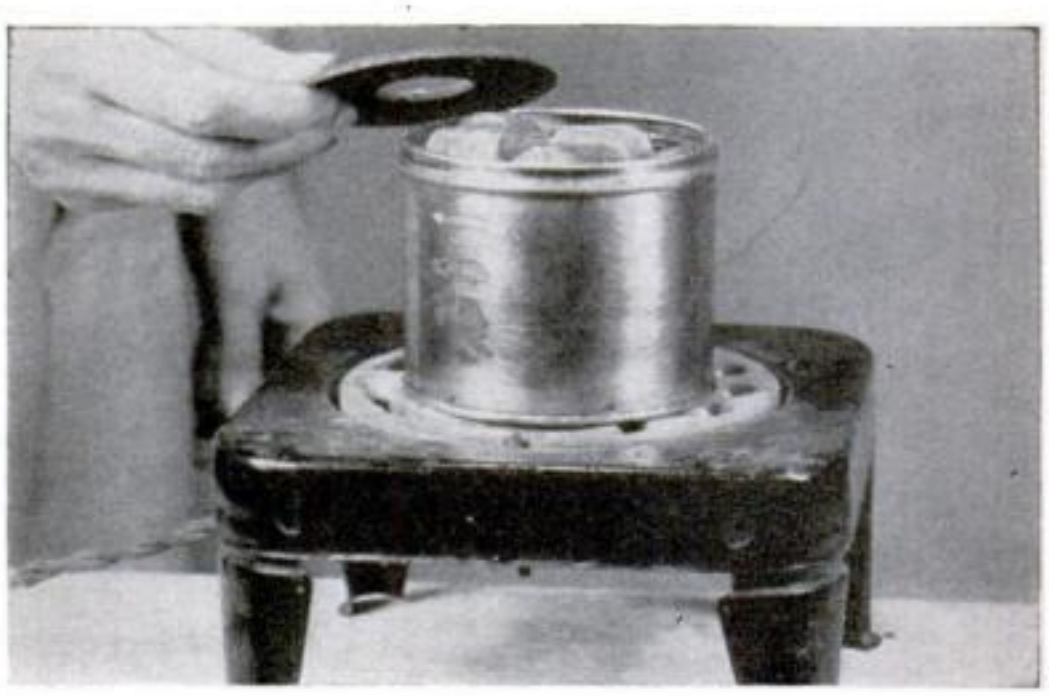
Cork accumulates in layers one to four inches thick, and is stripped every nine years. Skillfully handled, a tree will renew its outer bark and may live 150 years.

The first stripping produces rough, uneven "virgin" bark; the third, really fine cork that looks very much like brand-new bottle stoppers—light, resilient, and soft. It retains these valuable properties even when cut up, ground, pressed, baked, molded, or sliced. In a compression test an inch cube remained unbroken under 14,000 pounds pressure, and sprang back to 90 percent of its former volume. Dead air locked in its cells was compressed, and then

HINTS ON THE PROPER CARE AND HANDLING OF CORKS



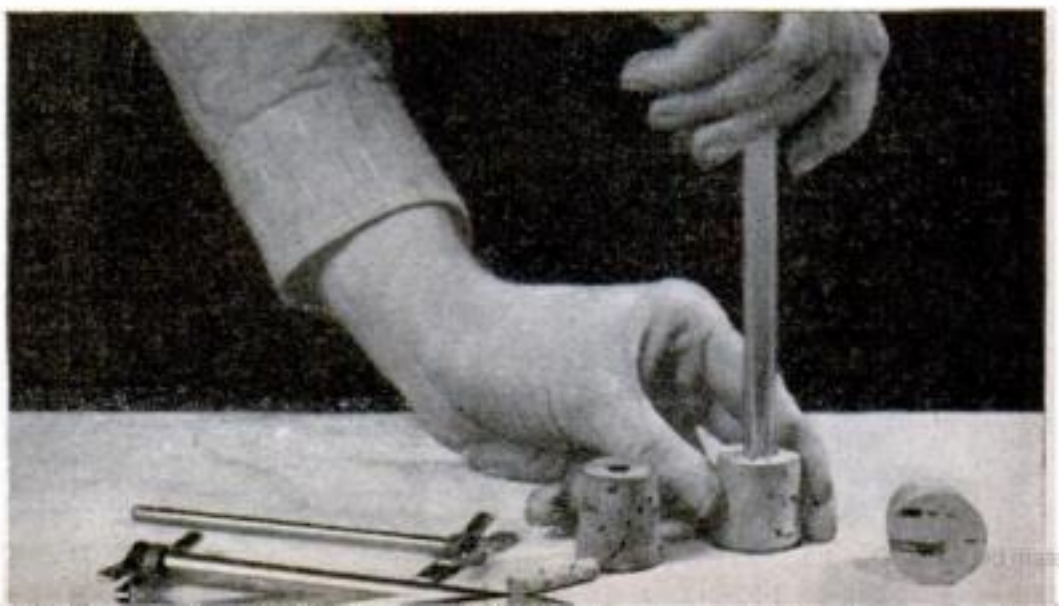
1 Rolling an old, deadened cork under a ruler or strip of wood, using moderate pressure, restores resiliency. But soak it in water first



2 Very old and dirty corks can be restored by alternately boiling and cooling two or three times. A weight will keep the corks immersed

5 Boring tools, commercial or homemade, cut smooth, even holes quicker if the cutting ends are turned first in a cake of paraffin

6 Hold the boring tool stationary and turn the cork. This keeps the cutting tube aligned for a clean, straight, and perfectly centered hole



expanded again with little leakage when pressure was released. These close-knit air cells also give cork its insulating properties.

Of all the processed forms of cork, "natural" cork is best known to the public. Boiled and dried for cleaning and softening, it otherwise is in its original form. Natural cork is shipped in long striplike blocks. It may then be sliced into narrow slabs from which bottle stoppers are punched, trimmed and shaped into curved blocks for life preservers, or cut into other special shapes.

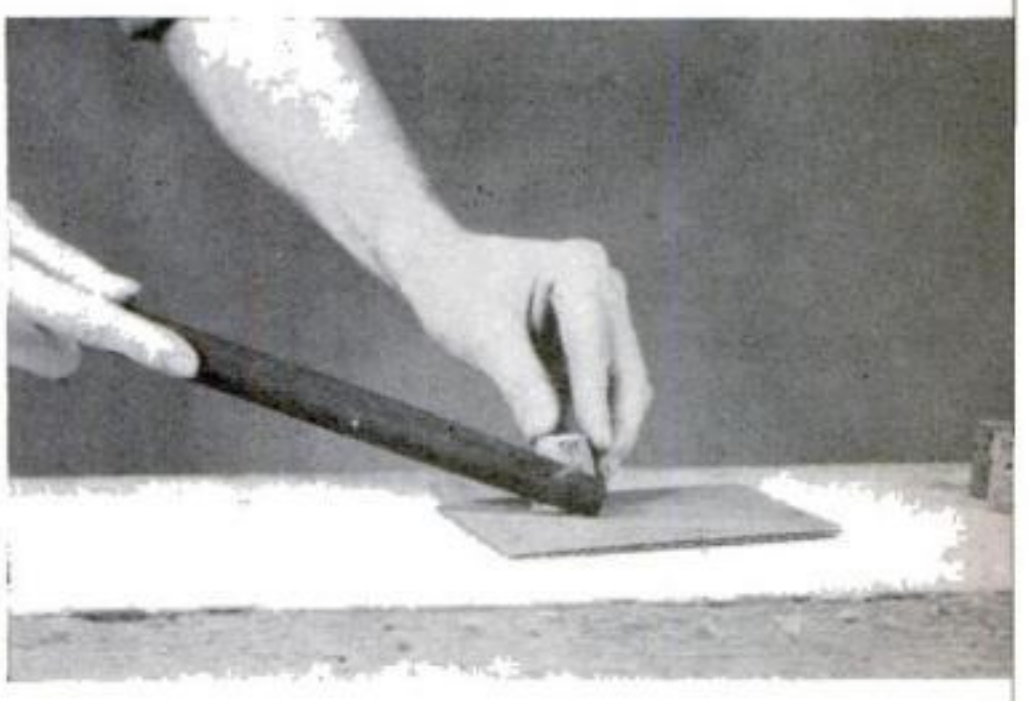
Whatever the use, much is left over after shaping—one manufacturer estimates it at more than 70 percent—but no part is lost; all goes on to further processing. This "waste" is combined with scraps of less desirable cork—including virgin cork and an inferior grade called "refugo" that forms 40 percent of every stripping—and then ground and cleaned. Cork board is made from this "granulated" cork by pouring the mass into metal forms and baking for four to six hours (or steam-baking for a much shorter time), while the natural cork resins bind the granules into a solid, cohesive slab. When cool, this can be trimmed and installed as an insulator.

A development of cork board is cork-tile flooring, baked twice as long and subjected to high pressure, so that it is heavier and provides a firm, resilient floor covering. Other variations are "isolation" cork board, a denser slab that absorbs noise and vibrations and is used under heavy machines, and acoustical cork board, a lightweight block for trapping sound waves and damping echoes.

Composition cork, another of the basic types, also is made from granulated cork, but has a special binder of glue or gelatin for closer cohesion. It is stiffer yet more easily worked than cork board, and can be cut, sliced, or molded for bottle-cap linings, motor gaskets, polishing wheels, wastebaskets, bulletin boards, table mats, inner soles, and part of the core of baseballs.

TO GET LONGER USE IN THE KITCHEN AND LABORATORY

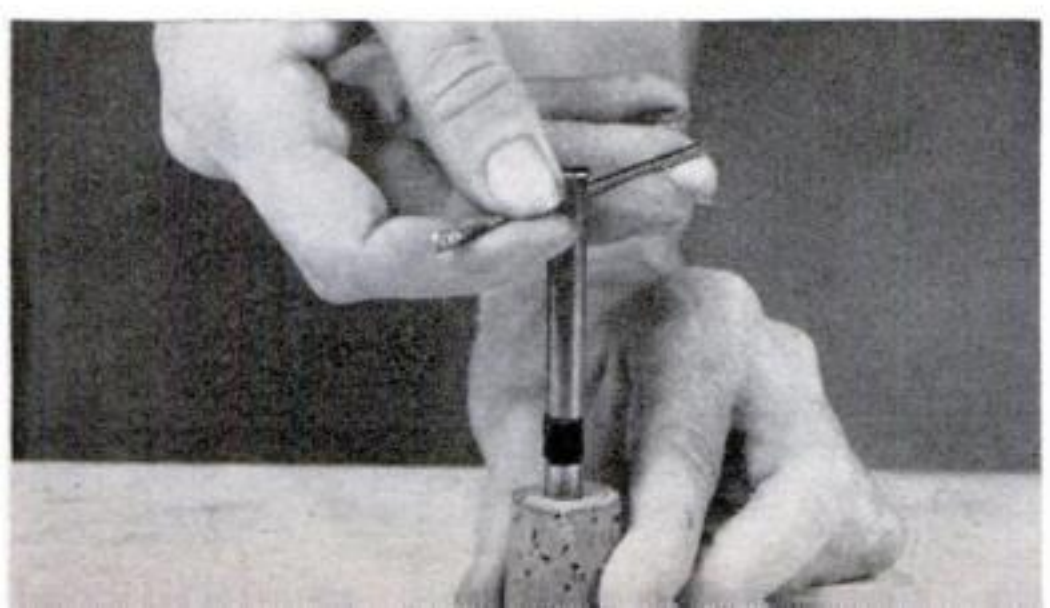
3 Cork dulls cutting edges quickly. Use a sharp knife, kept wet by frequent dipping in water. If the cork is thick, make several light cuts

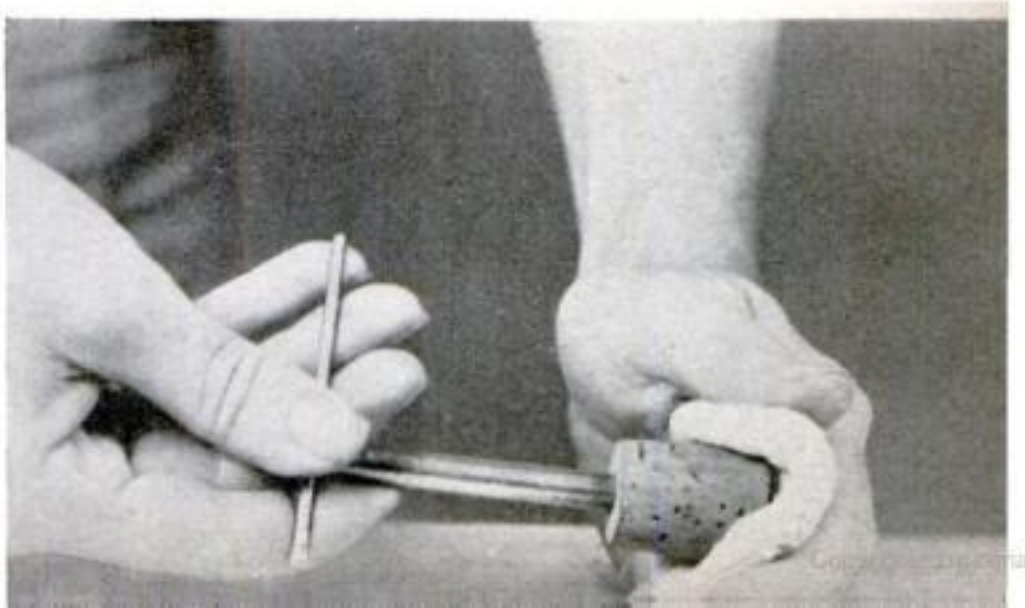


4 Light, horizontal strokes with a bastard-cut file held at an angle reduce diameter best. Keep the cork dry. Turn it after each cut

7 Tape on a boring tool, serving as a depth gauge, will permit easing of the cut to prevent chipping, or help in boring blind holes

8 When a cork must be held in the hand while boring, use a cloth or leather pad, or an old powder puff, as a guard against injury





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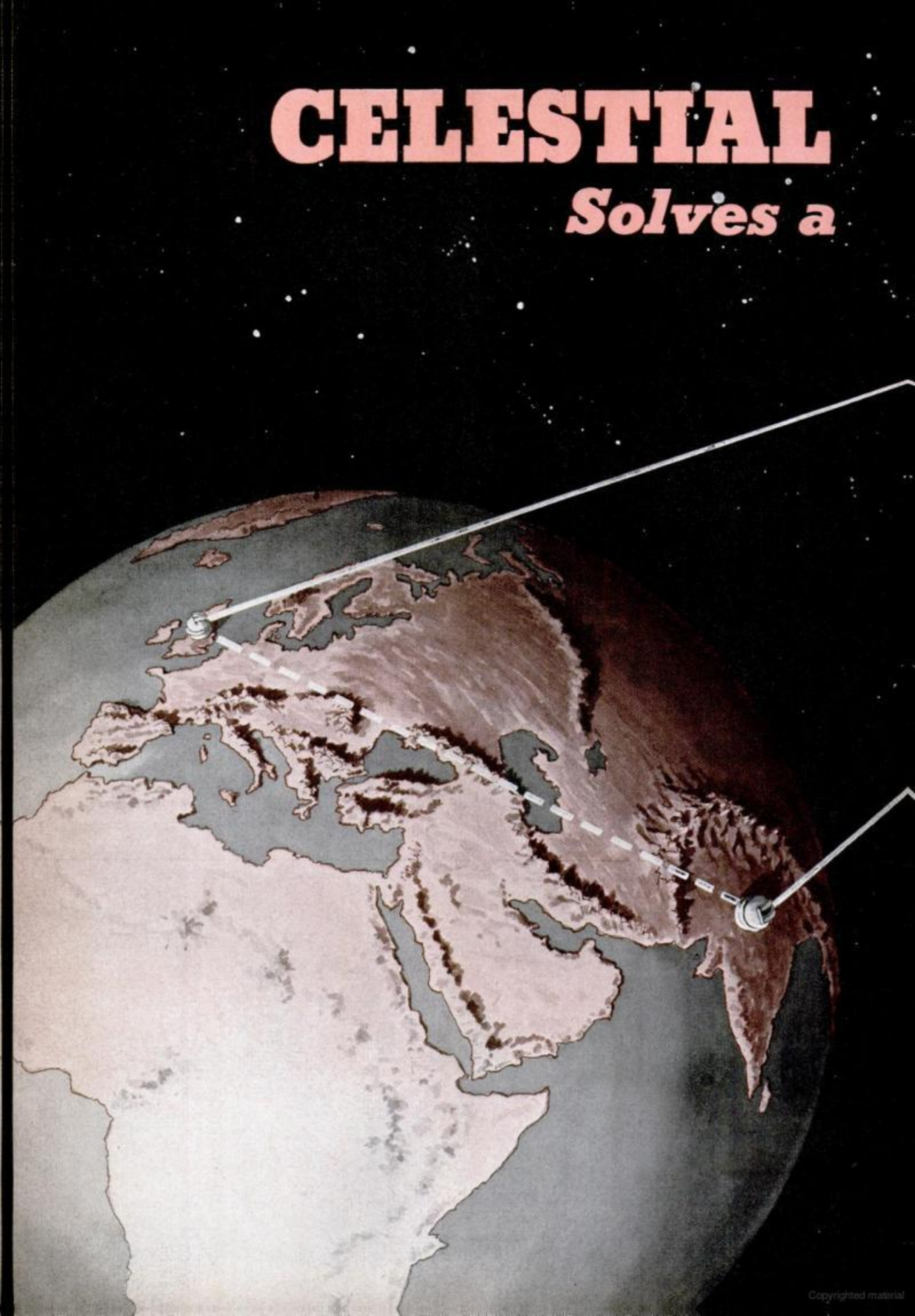

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YARDSTICK

300-Year-Old Problem

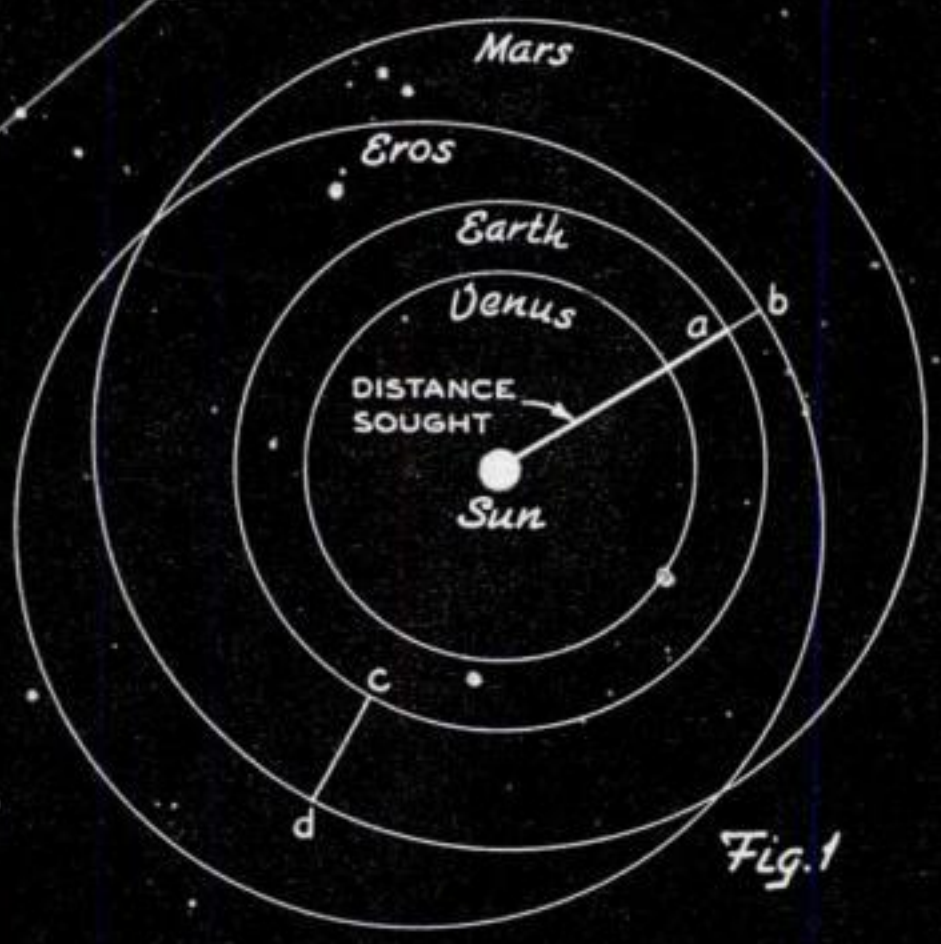

Fig. 1

How astronomers stretched a tapeline to the sun: To get an absolute measurement to an object in the solar system for use as a yardstick, they took triangulation shots at the asteroid Eros, which at times approaches nearer the earth than any other heavenly body except the moon. Mars was commonly used in former attempts. Longer base line and shorter distance adds accuracy

By
DR. DONALD H. MENZEL
Professor of Astrophysics, Harvard University

TEN YEARS of mathematical calculation, following more than a year of extensive observation by astronomers of 15 countries, have established the distance from the earth to the center of the sun at 93,005,000 miles. The new determination, which replaces the previous best value of 92,900,000 miles, was obtained by methods basically similar to the triangulation used by mundane surveyors, and is accurate within 9,000 miles, an uncertainty which corresponds to the apparent breadth of a human hair at 10 miles. Since the distance of the sun is the fundamental datum of astronomy, entering into nearly all calculations of size, density, mass, and distance of the stars, and of the planets and their satellites astronomers now possess the measuring tool which has been sought for centuries, a celestial yardstick with which the heavenly bodies can be accurately placed in space and maps of the solar system drawn to a *known* scale for the first time.

In determination of distance there are two fundamental methods—using a tapeline for measurement, or using a triangle and geometry. Since it is obviously impossible for astronomers to drag a tapeline to the sun, they must resort to the less direct procedure, which is in constant use by surveyors. For example, a man wishes to measure the distance from A to B across a large lake (Fig. 2). He will first set up another accessible station C, from which B is also visible. Next he will measure the distance AC accurately and also the angles at A and C. Suppose that AC is exactly 10 miles. The surveyor will

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draw a map with a scale of, say, one inch to a mile, and indicate AC by a line 10 inches long. He will then use a protractor to construct the angles A and C and extend the lines to the intersection B. With a ruler he will measure AB. If AB is 20 inches long, he will know that the true distance from A to B, across the lake, is 20 miles. If he prefers, he may use trigonometry instead of a drawing board, but the fundamental principle remains the same.

No matter how hard he tries, the surveyor cannot measure the distances and angles with absolute precision. Suppose that AC were one mile instead of ten, and that errors of one degree may have existed in his measures. From each of the points A and C he will have to draw two lines instead of one, to cover the range of his observational uncertainty. If the smaller angles are correct, the position of the unknown point is B; if the larger angles are correct, the point is at B^1. Actually, the observer can know only that the point lies somewhere along the line BB^1. With the larger base line, we find that the uncertainty BB^1 is far smaller. This demonstration is a graphic proof of the principle known to every surveyor—use as long a base line as possible.

Attempts to measure the distance from the earth to the sun by triangulation have been made at various times since Johannes Kepler, in 1618, discovered the third law governing the motions of the planets, by means of which, if the distance to any single object in the solar system can be measured, the distance to the sun can be correctly inferred. This law also made it possible to draw the solar system to scale, but the question re-

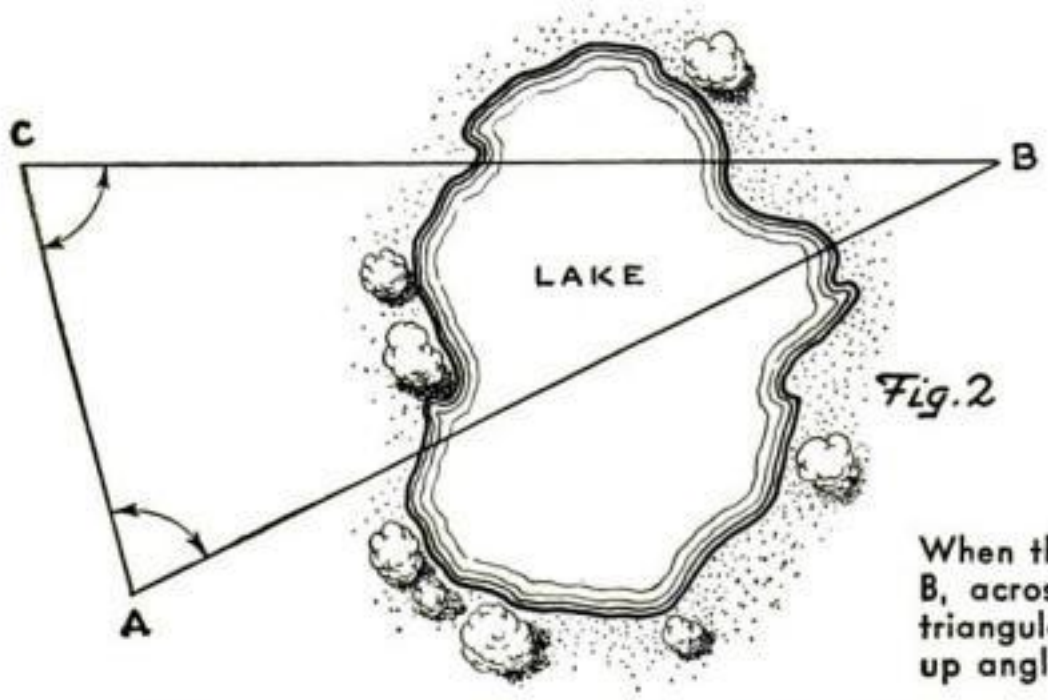

Fig. 2

When the distance from A to an inaccessible point B, across the lake, is sought, surveyors find it by triangulation. They measure the distance AC, set up angles at A and C, and then draw AB and CB

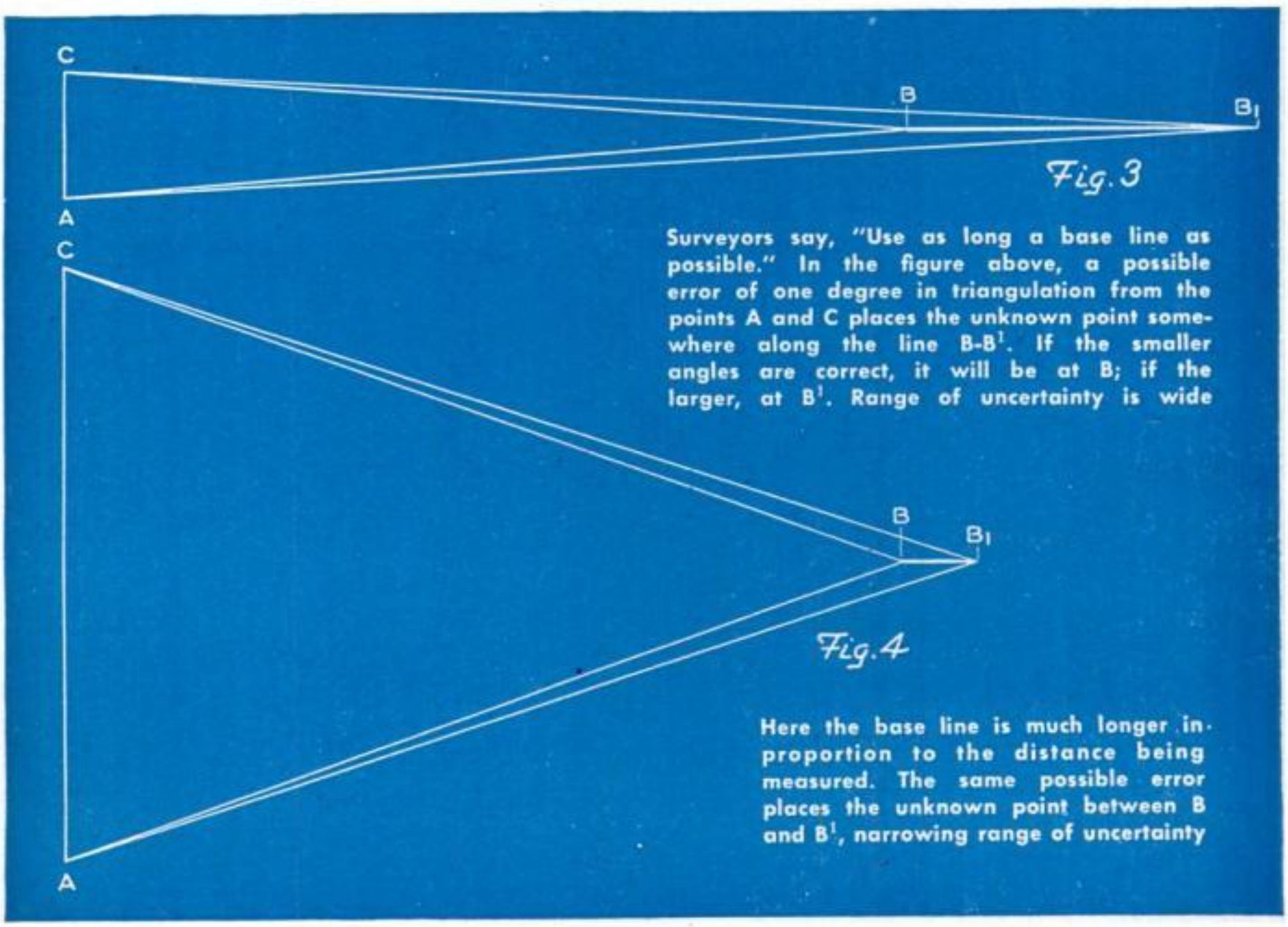

Fig. 3

Surveyors say, "Use as long a base line as possible." In the figure above, a possible error of one degree in triangulation from the points A and C places the unknown point somewhere along the line $B\text{-}B^1$. If the smaller angles are correct, it will be at B; if the larger, at B^1. Range of uncertainty is wide

Fig. 4

Here the base line is much longer in proportion to the distance being measured. The same possible error places the unknown point between B and B^1, narrowing range of uncertainty

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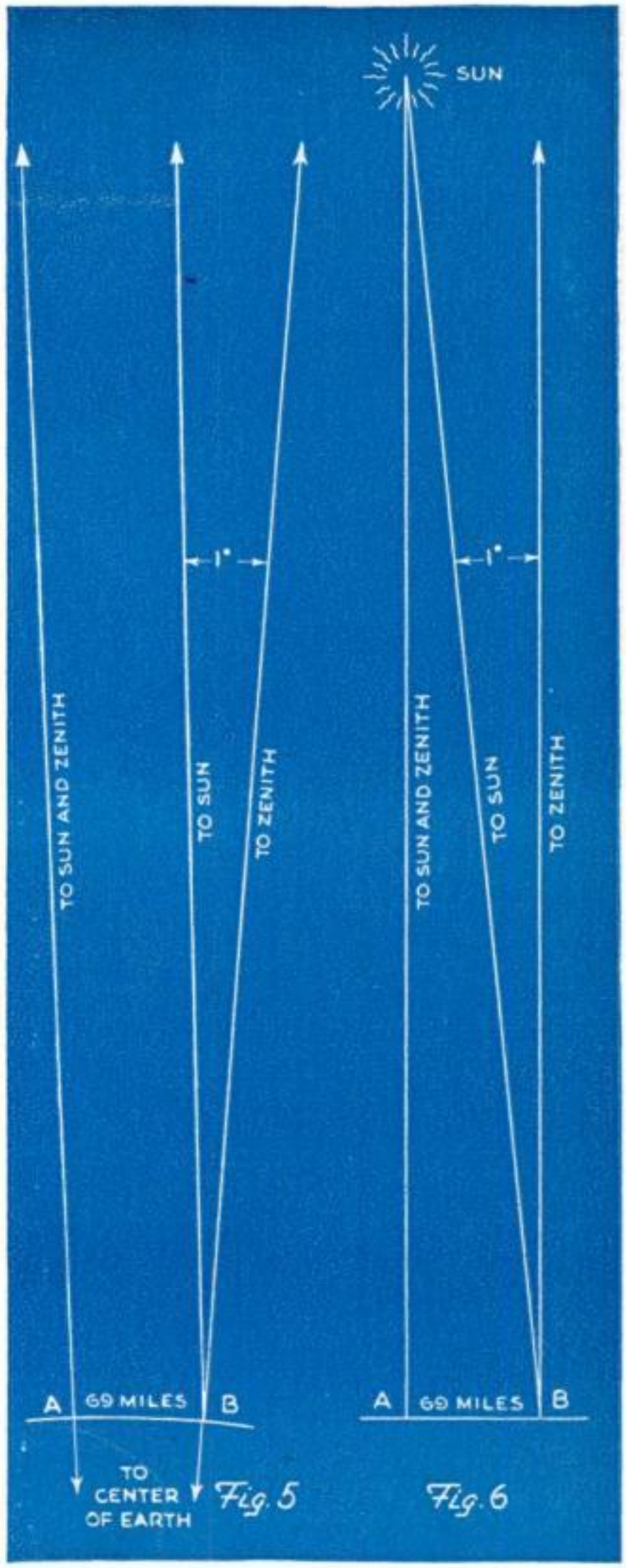
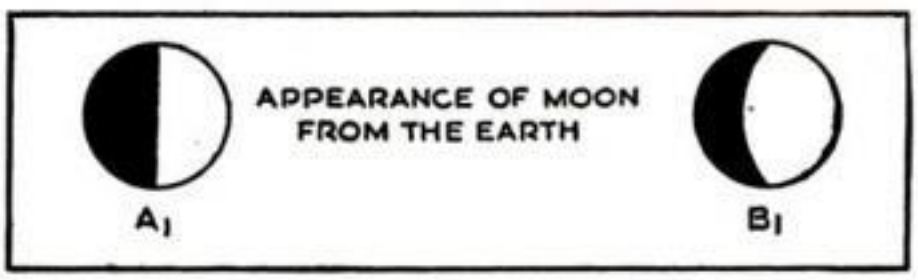
mained, what measurement to use as a scale?

The chief problem that confronted astronomers who tried triangulation was in getting a satisfactory base line. Even if telescopes were mounted at opposite poles, the earth offered a maximum of only 8,000 miles. Mars was too far away and, in addition, was not small and starlike, but a disk, which made for inaccuracies of setting. Moreover, its brightness compared with that of stars was so great that additional difficulties arose. In later years astronomers used several of the asteroids, principally Victoria, Iris, and Sappho, but though easier to observe, they were even farther away than Mars. Nevertheless, through observations of these bodies in 1888 and 1889, a solar distance of 92,874,000 miles was obtained.

Prospects of eventual success began to appear brighter in 1898, when the German astronomer Dr. G. Witt discovered the asteroid Eros, which at times comes closer to the earth than any other heavenly body except the moon. In 1900 and 1901, when the tiny planet, only 16 miles in diameter, was about 30,000,000 miles from the earth, astronomers of several countries undertook a co-operative program in an attempt to determine the solar distance, and found a value which agreed with that obtained by observation of the more distant asteroids. This program, however, was little more than a dress rehearsal for the very extensive project begun in 1931, when Eros came within 16,200,000 miles of the earth. For more than a year *(Continued on page 216)*





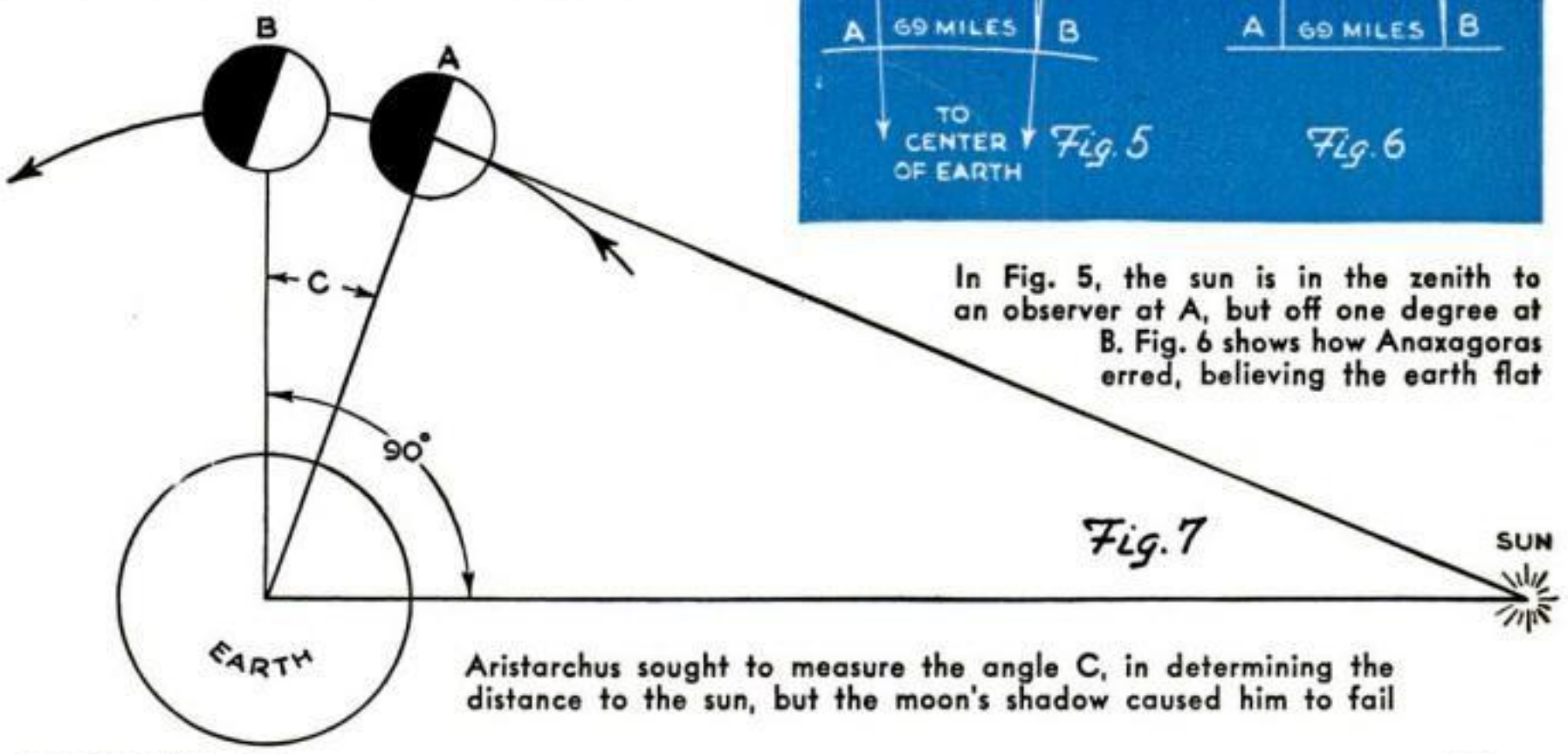


Fig. 7

In Fig. 5, the sun is in the zenith to an observer at A, but off one degree at B. Fig. 6 shows how Anaxagoras erred, believing the earth flat

Aristarchus sought to measure the angle C, in determining the distance to the sun, but the moon's shadow caused him to fail

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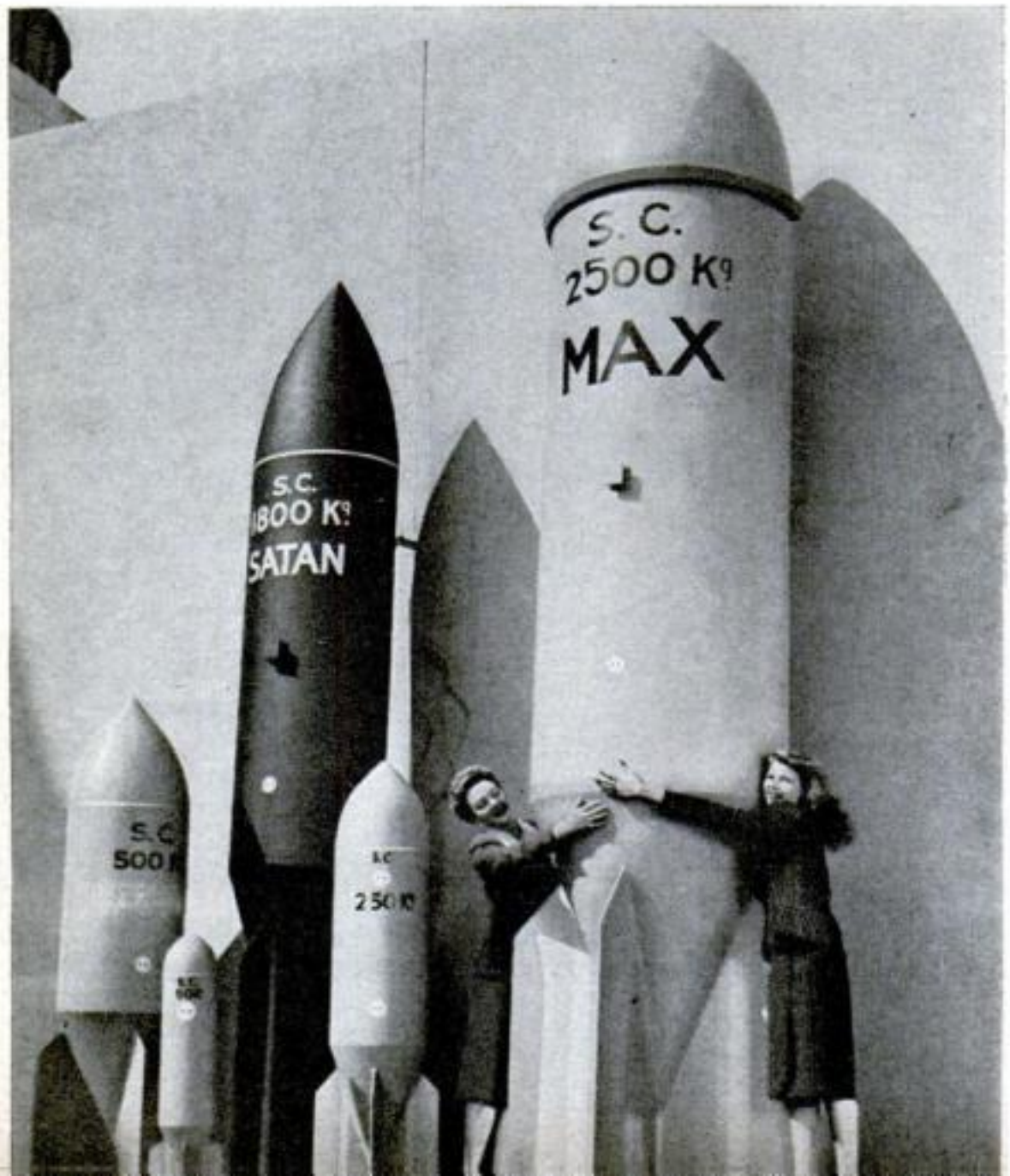
Models Aid Fighters to Spot Tanks

U. S. medium tank M-4 (General Grant) as it appears in scale model for recognition training of American soldiers. Below is one of its adversaries, the German light-medium PzKwIII Type C. Scale is 1 inch to 3 feet

SCALE models, accurately reproducing the appearance of principal types of German and American tanks, are helping to train U.S. soldiers in instant recognition of friendly and hostile armored vehicles. In the hurly-burly of a modern tank engagement, the lives of men and the outcome of battles may depend on split-second decisions as to whether mechanized units glimpsed fleetingly under varying conditions of distance and light belong to our own forces or to those of the enemy.



BIG BOMBS used by the Nazis have been reproduced by property men of Columbia Studios for exhibition in Los Angeles by the Office of Civilian Defense. The mammoth death dealer being embraced by the two girls in the photograph at the left is a replica of a 2,500-kilogram (about 5,500-pound) bomb nicknamed Max, which is said to be capable of demolishing buildings over an area six city blocks square. Max is more than 16 feet high and 12 feet in circumference. The black missile near by is Satan, weight 1,800 kilograms, while the others run to 500, 250, and 50 kilograms. The exhibit is designed to make residents of Los Angeles, and of other cities where it may be shown, more alert to the problems of civilian defense.

POPULAR SCIENCE

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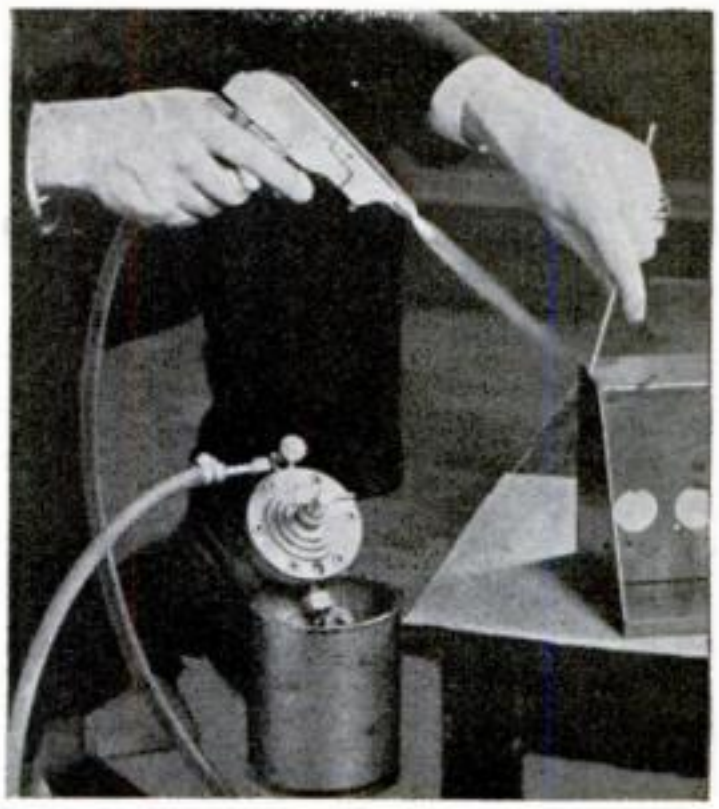
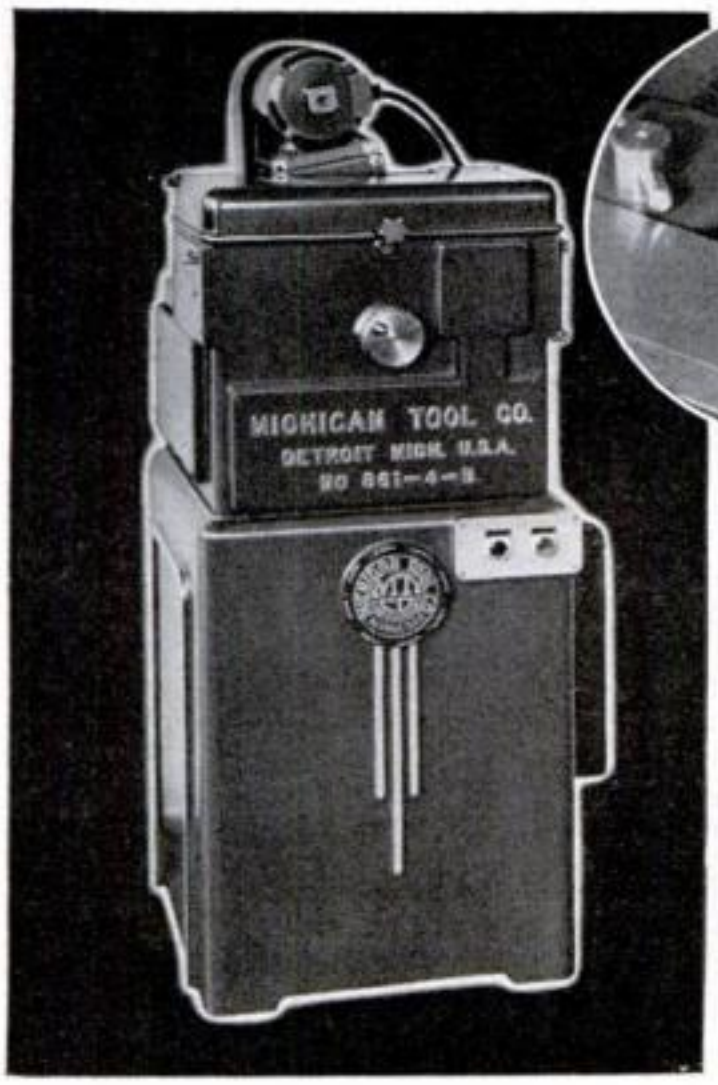
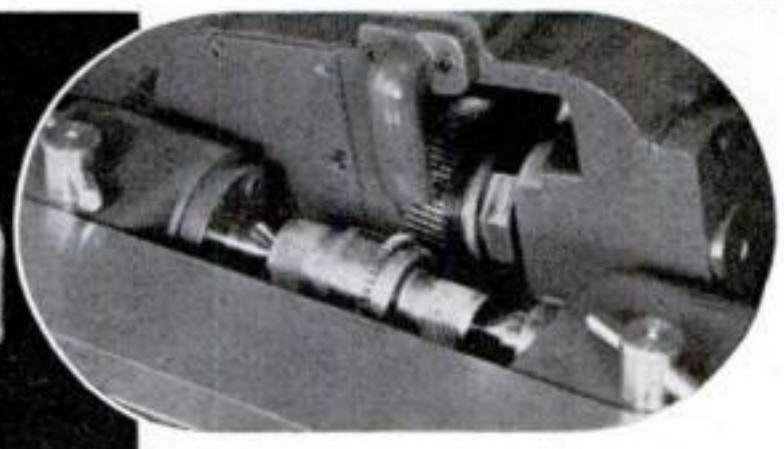
new Tools



THIS COMPACT GAS GUN is called the first self-firing, self-extinguishing acetylene torch to be put on the market. The trigger mechanism strikes a spark from a flint when pressed, causing the gun to blaze immediately. Small and easily maneuverable, this automatic torch is used for soldering, light brazing, and lead burning in cramped quarters.

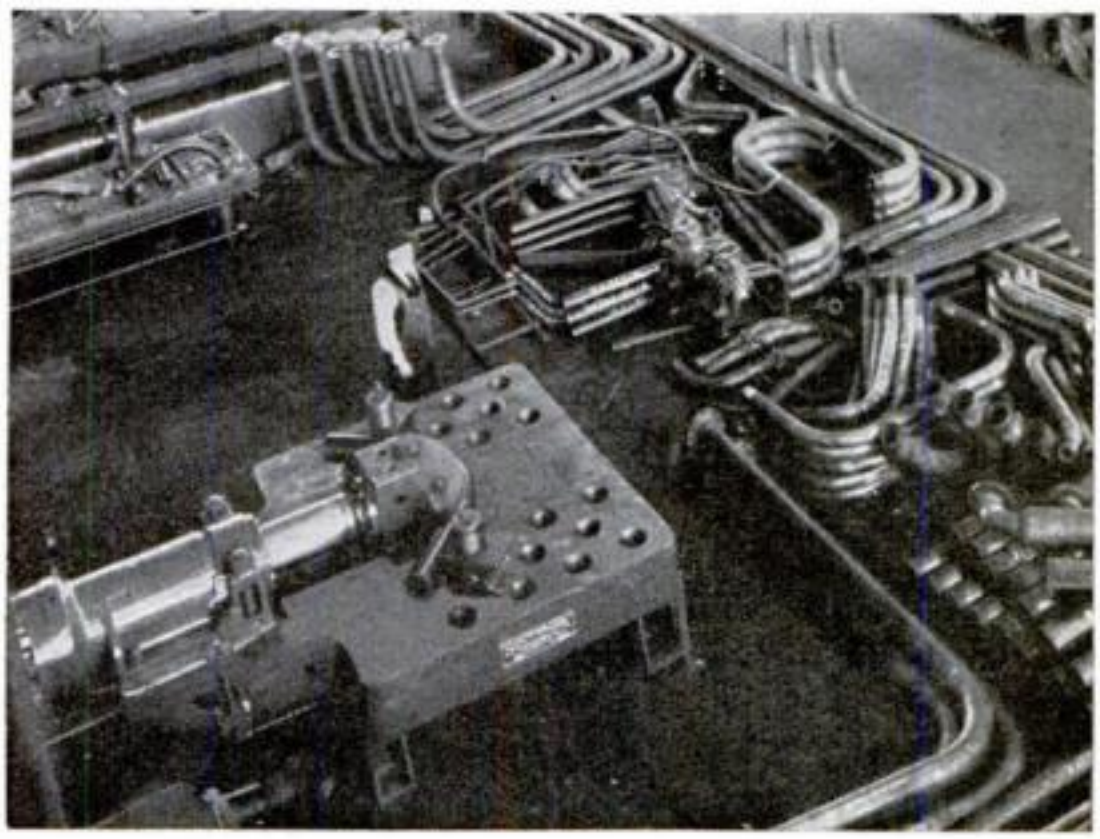




Left, gear mounted on a quick-assembly mandrel being finished on the new machine. Tail stock at the right has a single handle which will lock or unlock the center in one motion

FINISHING OF SMALL GEARS is facilitated by this new rapid-finishing machine, which operates by the crossed-axis principle of gear shaving. Designed for work on gears less than 4" in diameter and under 1" face width, the machine is especially handy in producing gears for instruments, control mechanisms, and other precision devices in which high accuracy must be combined with correct tooth formations. The machine's high speed makes it suitable for mass production, and it can be installed in a battery, enabling one operator to tend several machines at once. For battery installation, the mechanism is in the top casting.

A 200-TON BENDING PRESS has been especially designed and built to handle hydraulic pipe required in a variety of shapes by the war effort. Production experience has demonstrated that, because of the tremendous power of this machine, most pipes can be bent in it without preliminary heating or other special treatment. This feature is not only a great timesaver, but also eliminates the distortion that usually results in preheated pipes during the cooling process. This oil-operated press is under perfect control of the operator at all times—a valuable asset in making difficult bends.



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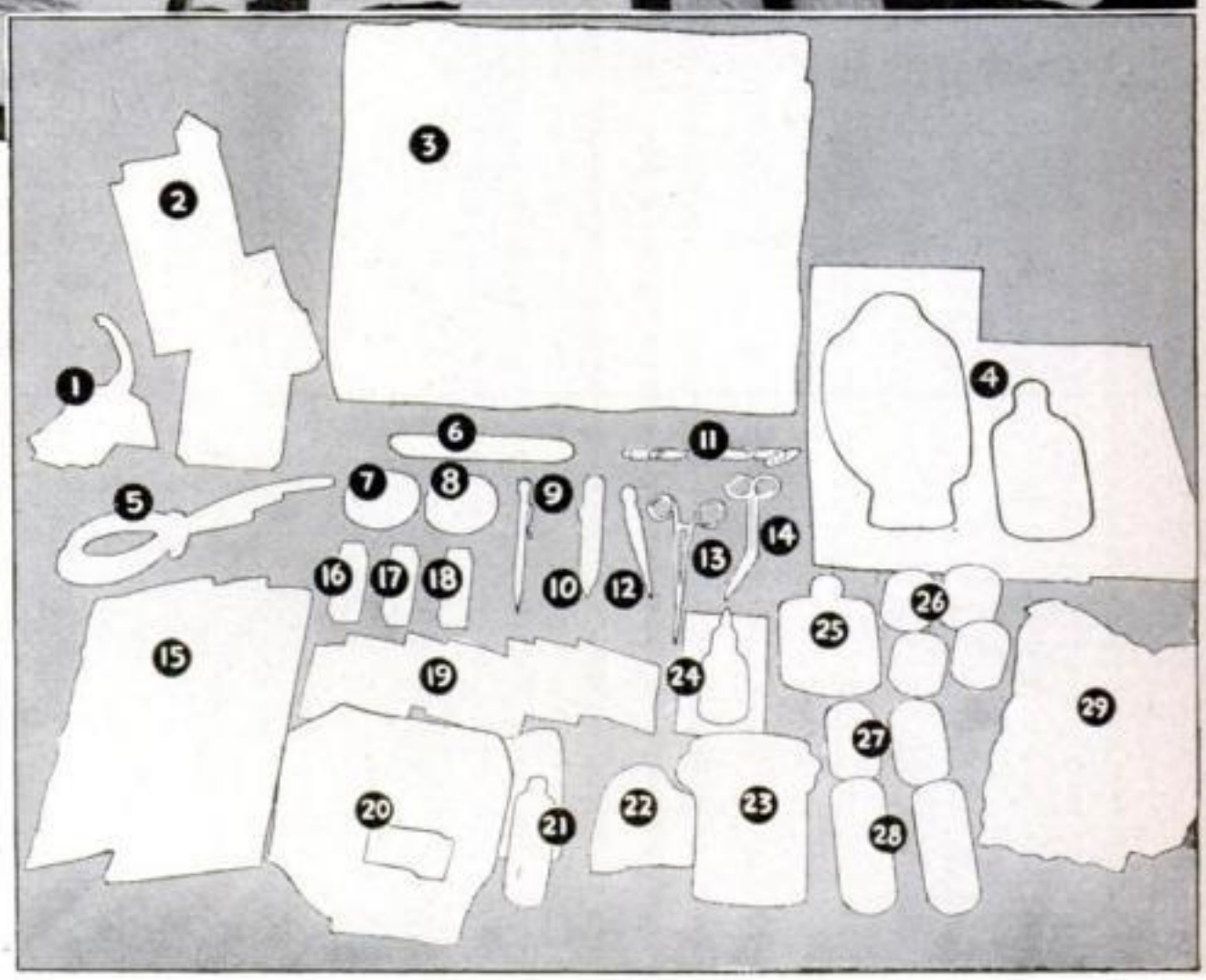

ITEMS IN NURSE'S KIT

1. Eighteen tags.
2. Triangular bandages.
3. Kit, folded.
4. Bottle and felt covering for water or coffee.
5. Combination tourniquet and drinking tubes.
6. Tongue blades.
7. Adhesive tape.
8. Stimulants: amyl nitrate, adrenaline, and caffeine with sodium benzoate.
9. Pencil.
10. Pencil-type light.
11. Safety pins.
12. Thumb forceps.
13. Hemostat.
14. Scissors.
15. Gauze for dressings.
16. Butyn and metaphen eye ointment.
17. Benzole eye ointment.
18. Pontocaine eye ointment.
19. Eye pads.
20. Hypodermic needles and syringe in sterilized roll.
21. Morphine sulphate.
22. Cotton balls.
23. Sulfathiazole.
24. Castor oil.
25. Alcohol.
26. One-inch bandage.
27. Two-inch bandage.
28. Three-inch bandage.
29. Fan-folded gauze dressing.

This complete set of first-aid equipment packs easily into the nurse's kit, shown folded flat in the photo at top. All the items are listed in the table, with numbers corresponding to those in the key drawing above

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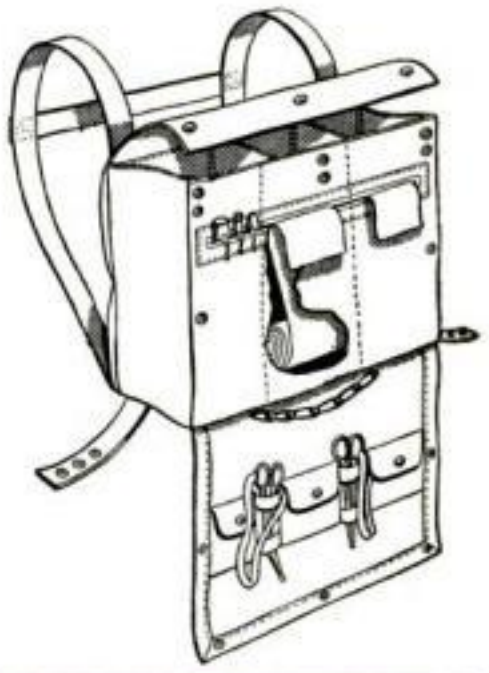
Walking First-Aid Station

MANY of the problems of administering first aid at the scene of war attacks or industrial accidents are lessened with the aid of this nurse's kit, worn as a back pack that can be swung around to the front where it will serve as a handy instrument and medicine "table." With the front flap unbuttoned and hanging down, bandages, dressings, stimulants, and first-aid instruments and accessories are at hand in easily accessible compartments and pockets. The kit was designed by Mrs. Clementine Campiglia, chief nurse for the Douglas Aircraft Company, to meet needs revealed by experience.

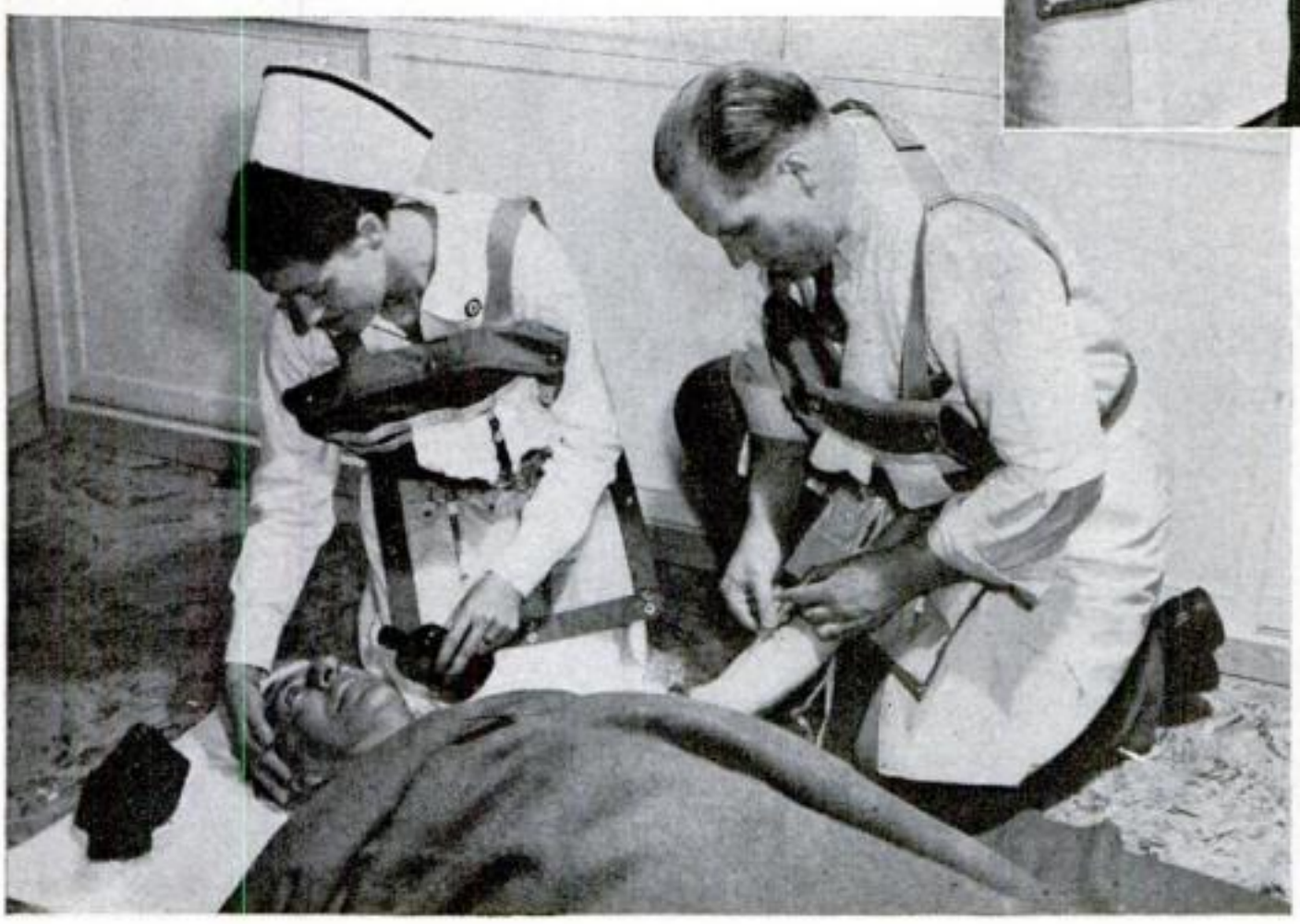
Bag and flap are built around three full-depth, vertical, dirt-protected compartments for dressings and bandages, the latter of which are pulled through slots so that none but that to be used is touched. Loops and pockets in the front and on the flap hold flashlight, pencil, forceps, scissors, and the like, hypodermic needle, swabs, stimulants, standard-size bottles of morphine, eye ointment, alcohol, and castor oil, and a bottle with felt covering that can be used for water or coffee. Two horizontal muff-type pockets on the back of the bag are accessible from the outside and are large enough to hold such items as splints and a vacuum bottle.

Heavy, serviceable duck is used for the entire kit, with pockets and flap lined with cotton. The harness of webbing is made along conventional lines, consisting of two shoulder straps and a cinch strap.



Heavy-duty duck and webbing are used in the kit and straps. The cut-out portion shows how rolls of bandage are used as needed

Kits are carried on the back, as worn above by the nurse, but can be swung to the front and the flap dropped when needed in an emergency



Doctor and nurse may work as a team, with two kits available. In addition to containing all the items listed for the nurse's kit, the doctor's may carry surgical instruments and extra sizes of hemostats and scissors

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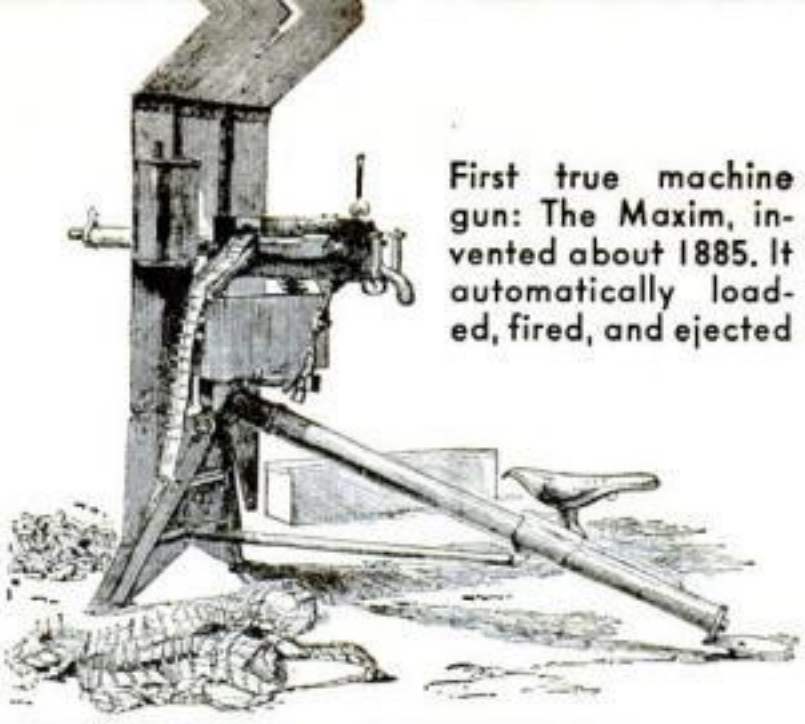


First true machine gun: The Maxim, invented about 1885. It automatically loaded, fired, and ejected

How America the World's

SUBMACHINE GUN

Parachutists, commandos, and other in-fighters of modern war find the Thompson (Tommy) gun just the tool for their work. Recoil-operated and air-cooled, it fires at the cyclic rate of 600-700 shots per minute, fed from a 50-round drum-type or a 20-round box-type magazine. Another gun, the Reising, is used by Marines

has Developed
Best Automatic Weapons

YANKEE INVENTIVE GENIUS, PLUS THE LESSONS OF THE WAR, GIVE US THE LEAD IN THE ARMS THAT ARE MAKING HISTORY

By JOHN H. WALKER

AUTOMATIC weapons made history and changed the entire nature of warfare between 1914 and 1918. Autoarms are dominating the present war even more completely, and have undergone superb technological development, ranging in size from the toylike .25-caliber dress pistols worn by staff officers in some European armies up to bulky quick-firing antitank and antiaircraft guns of 40 or 50 millimeters.

Machine guns and automatic cannon, rolling across Poland on tanks and motorized vehicles, blasted the Polish armies and cut their famed cavalry to ribbons in a matter of days. The underarmed Poles used their own weapons to advantage at a few points, and when it was over the Nazis—to show that they were broad-minded—adopted an excellent antitank rifle of Polish design.

Parachute troops with light machine rifles and snub-nosed submachine guns captured bridges and canals, sprayed lead over air fields, and had a great deal to do with the swift collapse of the Netherlands. One type of Finnish submachine gun is credited with inflicting 70 percent of the estimated 250,000 Russian casualties in 1939-40.

The lesson could go on indefinitely. Fire power wins battles, and automatic weapons provide heavy fire power for relatively small combat teams.

And it is good to know that the U. S. forces are being plentifully equipped with automatic arms which, on performance and history, probably can be called the world's best, flatly and without qualification. The list of American weapons is so long, in fact, that some might wonder why we have so many. The answer is that each has its peculiar function and mission in war.

Starting from the bottom we have the famous Colt .45, the finest, surest, and hardest-hitting of all automatic pistols. This arm of officers, gunners, and specialists has a notable history, but it may be in its twilight, since the Army plans to replace it with the new .30 caliber M-1 carbine, a beautiful gas-operated rifle that weighs only

AUTOMATIC PISTOL. Traditional sidearm for officers, gunners, and other specialists

CARBINE. New gas-operated automatic .30 caliber weapon replaces pistol in many uses

GARAND RIFLE. This semi-automatic, gas-operated weapon replaces the old Springfield

SUBMACHINE GUN. "Tommy gun" of gangster fame. Deadly when used for close fighting

AUTOMATIC RIFLE. An all-automatic shoulder weapon. Uses .30 caliber shells in magazines

LIGHT MACHINE GUN, .30 caliber. Most portable weapon of its kind for infantry use

HEAVY MACHINE GUN, .30 caliber. Water cooling makes it capable of sustained fire

LIGHT MACHINE GUN, .50 caliber. Long-ranged, accurate. Used against mechanized units

AA MACHINE GUN. Another .50, water-cooled. For defense against all low-flying planes

37-MM. AA CANNON. Our second-biggest automatic, it is also mounted in airplanes

40-MM. AA CANNON. The Swedish Bofors, adapted. Used against either planes or tanks

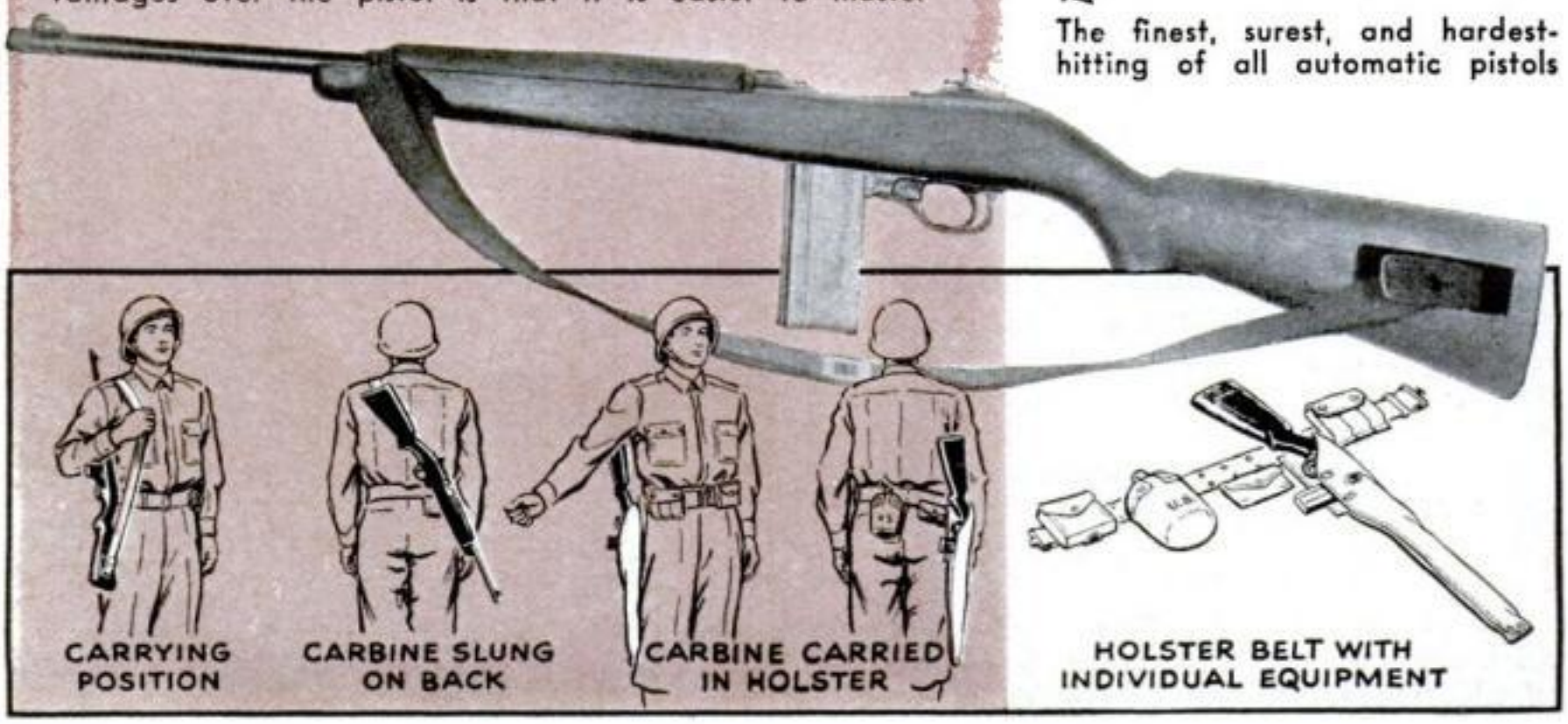
20-MM. CANNON. Another European design, the Hispano-Suiza adapted for airplane use

CARBINE

Replacing the .45 automatic pistol as the specialist's **arm, this beautiful new weapon combines** light weight **and small size with accuracy and tremendous** fire **power. It** is **gas-operated, feeding .30 caliber** cartridges from a box **magazine with a capacity of 15** rounds. Over-all length of **35½ inches and weight of less than 5¼** pounds are both **considerably under the** specifications **of** the infantry-**man's Garand rifle** shown on **the** opposite page. A brand-new weapon, it has its own manual of arms and its own carrying methods (illustrated below). Specialists armed with this gun will be prepared to offer effective resistance to inroads of enemy mechanized forces which are so common in fast-moving modern war. One of its chief advantages over the pistol is that it is easier to master

.45 PISTOL

The finest, surest, and hardest-hitting of all automatic pistols



5.12 pounds and takes a 15-shot magazine.

Next comes the most celebrated of new American arms, the Garand semiautomatic rifle, developed to replace the glamorous old Springfield as the standard shoulder arm of our soldiers, and the first weapon of this type to be adopted as the regular arm by any nation.

Between the admirers of the Garand and the Springfield there is no ill will. The Garand itself was developed at the Springfield Armory. Army riflemen explain it this way: In a peacetime competition they would take the Springfield with its unrivaled long-range accuracy and augmented fire power. The Springfield is a magazine repeating rifle with a hand-operated bolt; the Garand is gas-operated and delivers eight shots as fast as the trigger can be pulled. The same soldier, in actual war, can get off three to six aimed shots with the Garand for every one with the Springfield.

There is a special bracket for submachine guns, of which the most notable is the celebrated Thompson (Tommy) gun. This is being turned out in large quantities not only for our own forces but for the British, who love it. (Ask the commando who owns one!) Two other American submachine guns have been developed, the Sedgely and the Reising. The Reising, made by Harrington & Richardson, has turned up with the U. S. Marines in the Pacific.

These submachine guns are highly portable weapons, spitting clips of pistol-type cartridges and capable of terrible execution at close range. Most popular calibers are the .45 and the 9-millimeter Luger type.

Above that comes the solid family of American machine guns: The Browning automatic rifle, or BAR; the .30 caliber light MG and the heavy, water-cooled one; the light and heavy .50 caliber guns. All are brain-children of the late John M. Browning, the world's greatest inventor of automatic weapons, whose designs have been copied by most of the great powers and plenty of the small ones.

At the top are the 37-millimeter guns, for use in or against airplanes, and the

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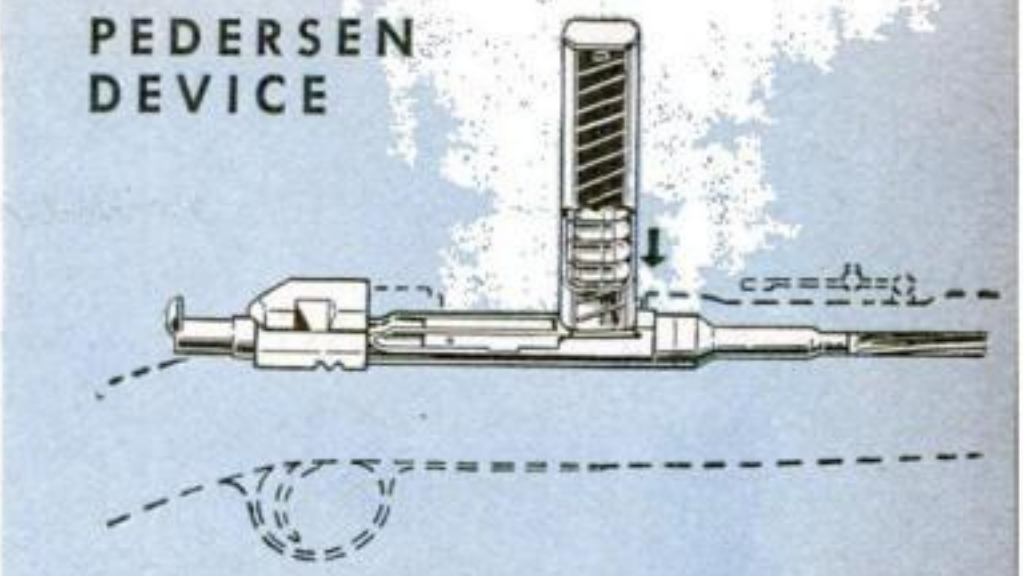

Secretly developed near the end of the First World War, this device could be inserted in place of the bolt in a Springfield rifle, converting it into an automatic weapon to fire small cartridges from a clip

STEN GUN

Britain's newest infantry weapon, a "machine carbine" **designed for** commandos and home guards, is so cheaply **and simply** made that it is called the "Woolworth gun." **Fires 550** rounds per minute from a 32-round magazine. **Has only** about 48 parts—and operates without oil!

GARAND RIFLE

First semiautomatic rifle to be adopted as the regular arm by any nation. Gas-operated, it delivers eight shots as fast as the trigger can be pulled, enabling the soldier to get off three to six shots for every one that he could deliver in the same time with the bolt-action Springfield. This means that the same fire power can be obtained with much smaller and more mobile bodies of troops

40-millimeter dual-purpose Bofors, which can be used against either planes or tanks. Then there is the 20-millimeter Hispano-Suiza, like the Bofors a European design, which we are now adapting as an airplane-carried cannon. The Navy uses a 20-mm. Oerlikon against dive bombers.

Occasionally military writers speculate on larger automatic guns, and there would appear to be no technical reason why large artillery pieces could not be designed to load, aim, and fire by remote control, especially in antiaircraft emplacements. The limiting factors would be rather such considerations as size, weight, and mobility.

Production figures on American manufacture are secret. But President Roosevelt disclosed last summer that in one month we had turned out more than 50,000 machine guns. That did *not* include submachine guns. Those weapons are telling their own story now, in many parts of the world.

The history of automatic weapons goes back into the early 16th century, and yet its entire significant development lies within the last two generations. Moreover, American gun experts, who were almost the last to tackle the problem, have made the most important advances.

As nearly as we can determine, the nameless genius who put together the first gun—some kind of wooden tube to blow out a missile with the force of burning gunpowder—must have started an hour later trying to do something about rapid fire.

The first technique was several barrels on a single mount, discharged simultaneously, or in quick succession, by means of a powder train. The first certain use in battle was by Pedro Navarro, a Spaniard, against the French at Ravenna in 1512. The idea was amazingly persistent, and was still in use in our Civil War, with the "volley guns" of Billinghurst & Requa.

These were clumsy weapons with 24 barrels side by side between wide-set carriage wheels. The makers put on demonstrations in front of the New York Stock Exchange, but the Army showed little enthusiasm. The idea survives today with the familiar

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.30 LIGHT MG.

Baby of the American machine-gun family, the Browning .30 light is air-cooled. Cyclic rate of fire, 400-550 rounds per minute; maximum usable rate, 150. Muzzle velocity, 2,600-2,700 feet per second. Easily carried by a small crew

.30 HEAVY MG.

Practically the same gun as the light, with a seven-pint water jacket surrounding the barrel for cooling to boost usable rate. All Browning machine guns in U. S. service have the same principle of operation by recoil and are belt-fed

double-barrel shotgun and the four-barrel multiple anti-dive bomber guns British Navy men call "Chicago Pianos."

The stumbling block for 300 years was the problem of igniting the powder charge. One design tried to meet this by loading along the barrel with successive charges of shot and powder. Touchholes were provided at suitable intervals, and the trick was to start near the muzzle and go down the barrel.

An automatic gun became a real possibility with the development of the metallic self-igniting cartridge, which could be discharged by the percussion of a hammer or firing pin. The first application resulted in *mechanical* rather than *machine* guns. As early as 1718, an Englishman named James Puckle took out a patent on a machine called a "Defence," which in profile drawing looks amazingly like a modern machine gun. It had a single barrel and a set of revolving breech cylinders, turned by a crank, but it had to be fired by a slow match. Mr. Puckle couldn't resist including a provision to fire round bullets at Christian enemies and square ones at Turks.

The French developed a crank-operated gun, the mitrailleuse, between 1855 and 1869. This had 37 barrels in a circular housing like the barrel of a field gun, and was loaded with a breechblock clip having cartridge chambers lined up with the barrels. The gun had serious mechanical bugs and was misunderstood by the French, who used it as medium-range artillery rather than a close-range infantry weapon. Its failure in the Franco-Prussian War gave quick-firing weapons a black eye for years.

The first thoroughly successful mechanical gun was invented in 1862 by Dr. Richard J. Gatling, of Chicago. It had from

EVOLUTION OF THE MACHINE GUN: FOUR STAGES IN ITS DEVELOPMENT

Multiple barrels and gravity feed distinguished early "mechanical guns"

GATLING

GARDNER

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.50 LIGHT MG.

Larger caliber makes this air-cooled gun an effective weapon against tanks and other mechanized units, and also against enemy machine guns and antitank weapons. Cyclic rate of fire, 400-500 rounds per minute; muzzle velocity, 2,660

four to ten barrels, revolving by crank power and firing from a breech mechanism with ammunition fed from a hopper. The Gatling gun was adopted and modified all over the world, and was in general use for 20 years after a genuine machine gun had been brought out.

This first true *machine* gun, in which the shells were loaded, fired, and ejected in a continuous automatic cycle, was invented around 1885 by Hiram Maxim, a native of Maine, who later became a British subject. Maxim's gun employed the recoil of the explosion in the cartridge to move the bolt backward and eject the empty shell. Two heavy springs absorbed this motion, then drove the bolt forward again, loading and firing another cartridge. Maxim also developed a belt feed. Since his gun had only one barrel, he designed a circular water jacket for it to prevent overheating.

.50 AA MG.

A water-cooled version of the .50, capable of long-sustained fire. Highly effective against low-flying planes. Often used along with 37 and 40-mm. guns

The next great basic invention was the Colt Browning gas-operated machine gun. Instead of using the recoil to actuate its mechanism, this gun had a tiny hole tapped in the underside of its barrel. A slight amount of the gases driving the bullet rushed into this opening, striking a piston and knocking down a lever which worked through a connecting rod and performed the ejecting, cocking, and loading. This was soon modified to employ a piston driven backward instead of down.

There are many variations of these two

So-called machine guns before the Maxim were really only mechanical guns; they were operated by means of a crank or lever. With the Maxim came truly automatic fire, in which recoil loaded, fired, and ejected shells. Browning's .45 Colt, below, was adopted as the official weapon of the U. S. Army in 1890

MAXIM

BROWNING

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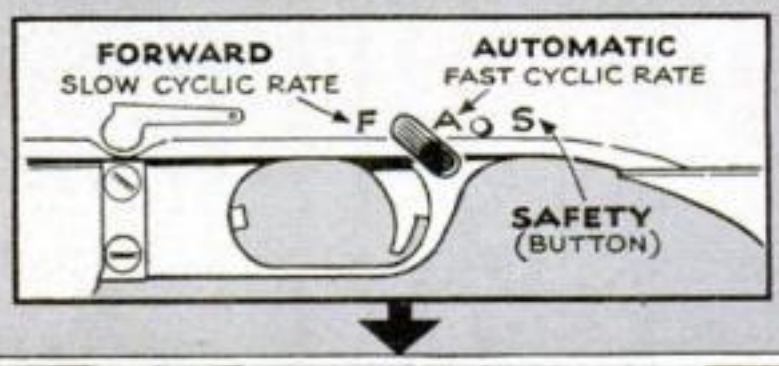
BROWNING AUTOMATIC RIFLE

This .30 caliber air-cooled, gas-operated, and magazine-fed weapon may be used either with or without the aid of a bipod. It has two cyclic rates of fire, normal at 550 and slow at 350 rounds per minute, selected by means of the change lever shown below. Effective rate is 120-150. Butt strap holds weapon against the shoulder while 20-round magazine is inserted



systems. Gun experts talk of "simple-blowback" or "delayed-blockback" recoil. And there are weapons in which the gas "expands" or "impinges" against the piston. Further differences exist in the manner in which the counter spring is connected with the gas-driven piston. But in general all automatic weapons are operated either by recoil or gas.

Even a superficial study brings proof of the dominant influence of American inventors. The celebrated German Luger automatic pistol, for example, is a modification of the toggle-joint action marketed in 1893 by a Connecticut man named Berchardt.

But American gun design reached its peak in the incredible career of John M. Browning. When he died in 1926 on a visit to Belgium, his body lay in the great National Arms Factory at Liege. During the World War he had been decorated with the Belgian Order of Leopold at the completion of the 1,000,000th Browning pistol there.

Browning designed weapons for all the great American companies—the full line of Colt automatic pistols, including the .45; most of the Winchesters for 30 years; autoloading shotguns and rifles for Remington and Stevens.

He was born in Ogden, Utah, of Mormon parents. His father, Jonathan Browning, had run a gunshop in Council Bluffs, Iowa, before moving west. In his early teens, Browning made a rifle: by 1880 he had designed a single-shot weapon that opened the eyes of Winchester's experts, and ten years later his Colt Browning machine gun was adopted as the official weapon of the U. S. Army. Browning's fame didn't reach the public, however, until the first World War, when it was suddenly announced that our

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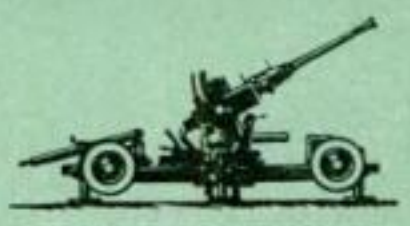
37-MM. CANNON

Here we're up among the big ones. This antiaircraft gun is fed its ammunition in clips of ten rounds. It can be aimed either manually, as shown, or by means of a director which automatically computes firing data for transmission to the aiming mechanism of the cannon



40-MM. CANNON

Biggest of our automatics is the Swedish Bofors gun, adapted for use against both aircraft and tanks. Easily identified by its bell-flared muzzle. Larger bore gives it a little more punch than the 37-mm. gun

Army was adopting an entire new family of machine guns designed by an "unknown" named Browning. They are still our standard—the handy shoulder-operated Browning Automatic Rifle; the light and heavy .30's for use against personnel; the enlarged .50-caliber MG with its extra punch against airplanes or light vehicles. The BAR is gas-operated, the others by recoil.

America has designers today carrying on the tradition. Will they produce new weapons to blast our enemies? Well, new weapons are necessarily secret weapons in war time, and our Ordnance chiefs say only that surprises are in store.

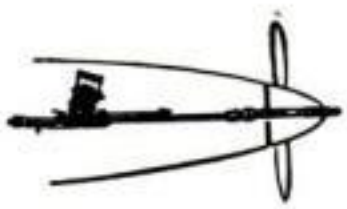
But it is not out of line to discuss two "surprise" weapons now no longer secret—one of them a new gun in this war, the other a World War invention which missed fame by the accident of time.

The first is the British "Sten" gun, a slightly overgrown machine pistol which looks almost comically like a youngster's popgun but throws a murderous stream of slugs at short range. It is being mass-produced for less than eight dollars a gun.

The second gun was the mysterious "Pedersen device." It was officially known as the "U. S. Pistol, caliber .30, Model 1918." That was done for secrecy, so that even the workmen who made the parts wouldn't realize what they were doing.

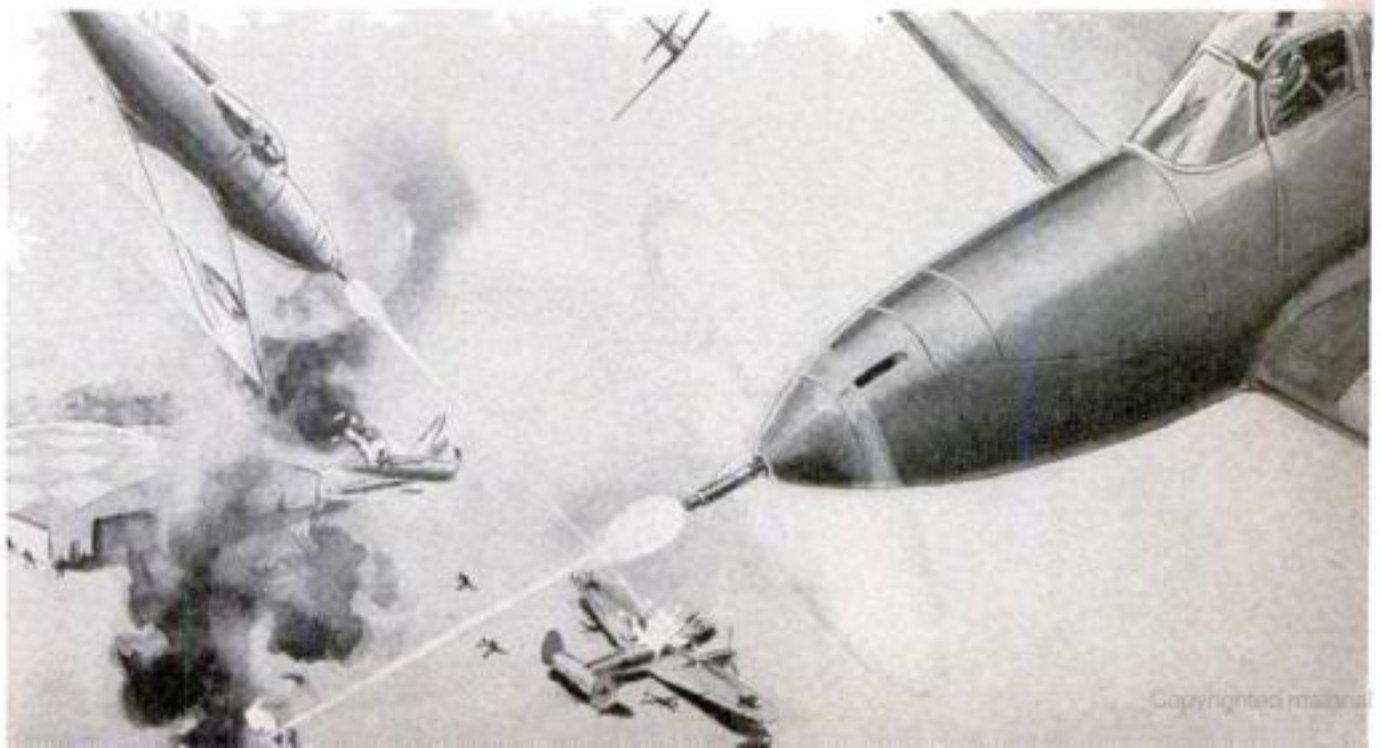
Actually the Pedersen device was a special bolt-and-breech assembly designed to replace the standard bolt of the 1903 Springfield and convert it into a submachine gun, spitting out 80-grain bullets from a detachable 40-shot box magazine.

More than 80,000 of these bolts were ready when the Armistice came in 1918; unquestionably they would have been one of the meanest surprises of the war. They were scrapped when development of the submachine gun and automatic rifle outmoded them. But it may be that something as ingenious and lethal is in the making.



20-MM. CANNON

A Hispano-Suiza gun adapted for use as an aircraft weapon. Designed for mounting on in-line plane engines. Fires 600 to 700 shots per minute



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AUTOS

Aligned Wheels Save Tires

CASTER, CAMBER, TOE-IN, AND TOE-OUT ALL CONTRIBUTE

By SCHUYLER VAN DUYNE

WITH the first two-wheeled cart came the problem of steering geometry. If the wheels were not parallel, one or both would have to skid as the cart moved. It is a vastly more complicated task for geometricians to figure out the relative position of the four wheels of a modern automobile, with the front ones pivoted, with all on springs attached to a rigid frame, and with numerous other factors necessary to skidless operation to be considered. If the geometricians hadn't succeeded, tire mileage of the kind possible today would never have been attained.

When you bought your new car, its steering geometry was close to perfect. But if you've driven it 5,000 miles since then, or even less, it is time for you to have its wheel alignment checked and, if necessary, returned to proper adjustment.

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The adjustments usually are needed to correct various mounting angles of the front wheels. These angles are the caster, camber, kingpin inclination, toe-in and toe-out of the wheels in relation to the center lines of the car from front to rear, side to side, and up and down.

Before checking these angles, however, your wheel-alignment expert will satisfy himself that your tires are properly inflated, that no wheel is bent or out of balance, that the front-wheel bearings are adjusted, that shock absorbers function properly, that the steering gear itself and its various connecting arms and links are in good condition, that parts are properly lubricated, and that the rear wheels track and are of equal distance from the corresponding front ones. All of these are important to good tire mileage, and necessary to good wheel alignment.

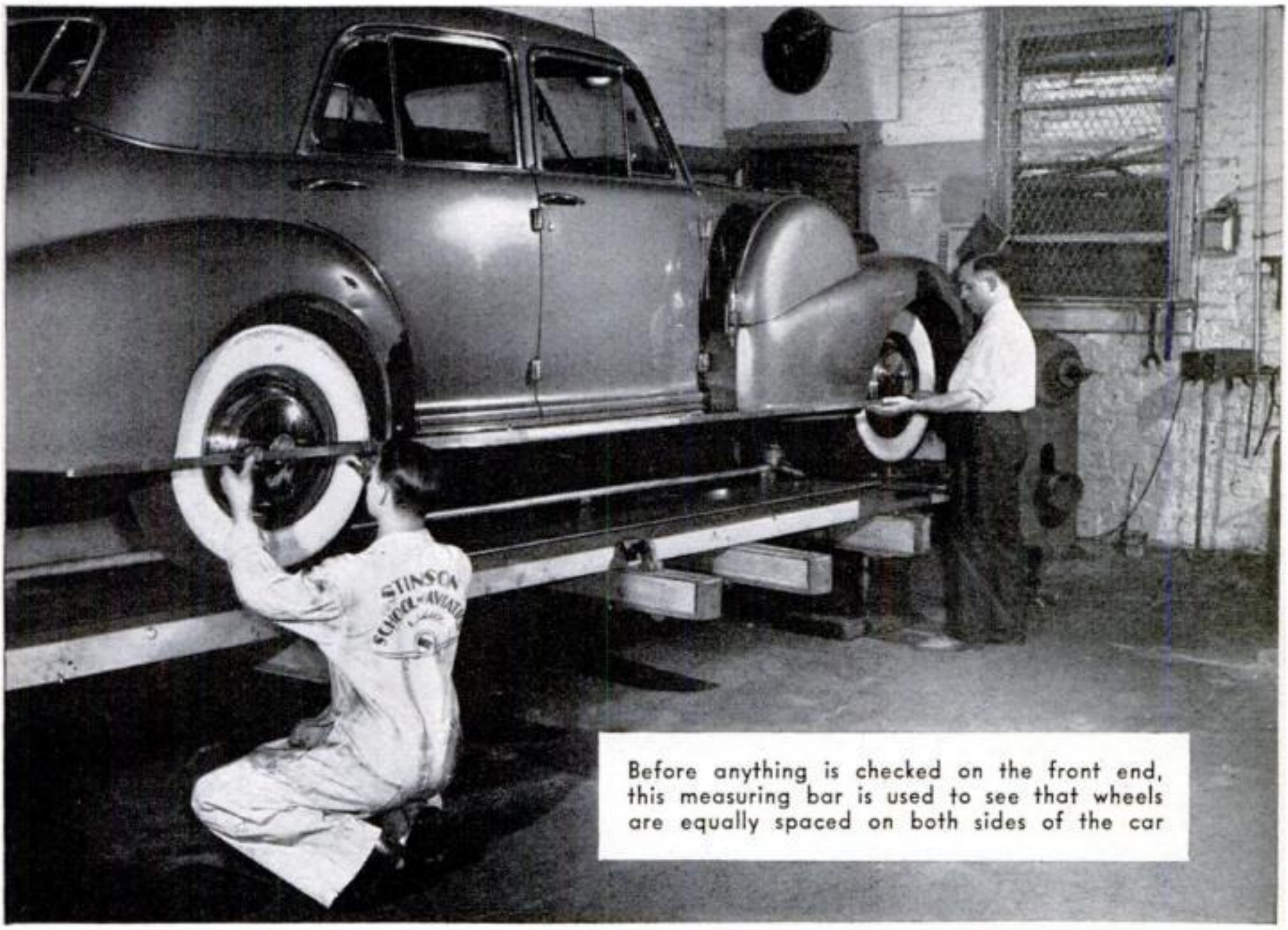
Caster, as the name implies, is a furniture-caster effect produced by the fact that the wheel contacts the ground behind the center line of the steering-knuckle pivot, called the kingpin. However, the actual design more nearly resembles that of the tilted front-wheel support of a bicycle. The kingpin tilts back at the top. Turning the wheel from side to side means that the load on the kingpin must be raised. Gravity resists this so that the wheel automatically assumes a straight-ahead position.

While caster has little direct effect on tire wear, it must be correct before it is possible to obtain correct wheel camber, and camber and its closely related component, toe-in, have much to do with tire wear.

Camber means simply that the wheel is tilted out from the car at its top. In other words, the wheel spindle of the steering knuckle points slightly below the horizontal. Just as a barrel hoop will tend to roll in a curve if it is not upright, the wheel similarly cambered tends to turn outward. The purpose of camber is to bring the kingpin weight more nearly over the point of contact of the tire with the road, relieving the kingpin of twist and strain. To bring it fully over this point would call for excessive camber, so a compromise is made by tilting the kingpin inward at its top.

To overcome the outward-rolling tendency of the cambered wheels, they are held closer together at the front, or toed in, for straight-ahead travel. All these factors—camber, caster, kingpin inclination, and toe-in—are of such importance to tire wear that no one

Static balance (equal weight distribution around the rim of a wheel) and dynamic balance (equal distribution on both sides of the center plane) are tested and corrected on the balancer at left



Before anything is checked on the front end, this measuring bar is used to see that wheels are equally spaced on both sides of the car

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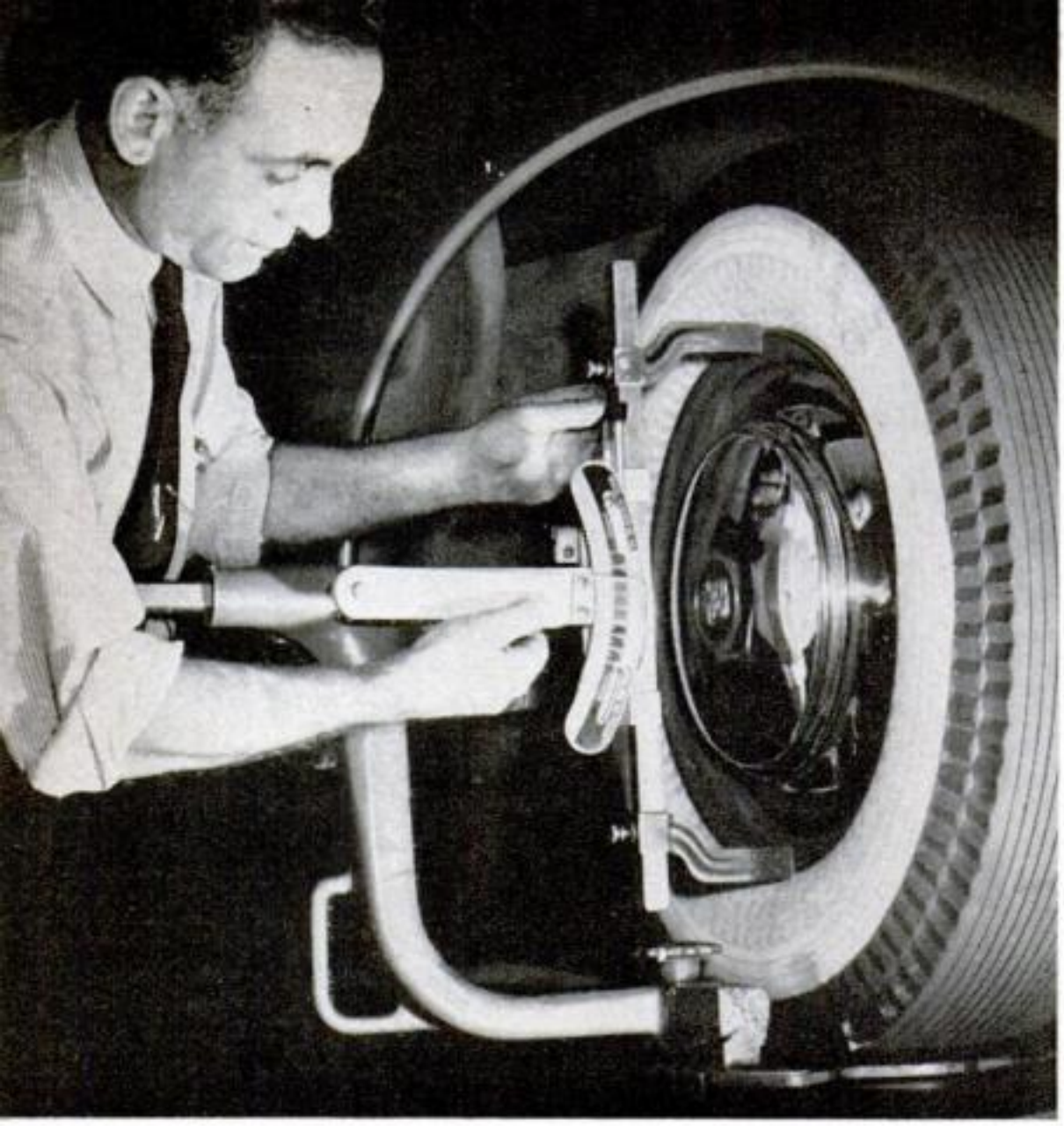
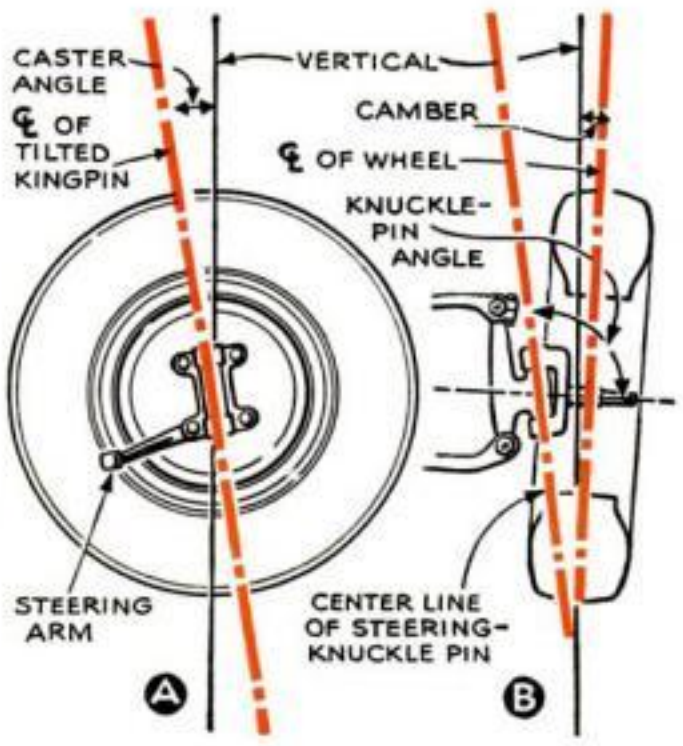


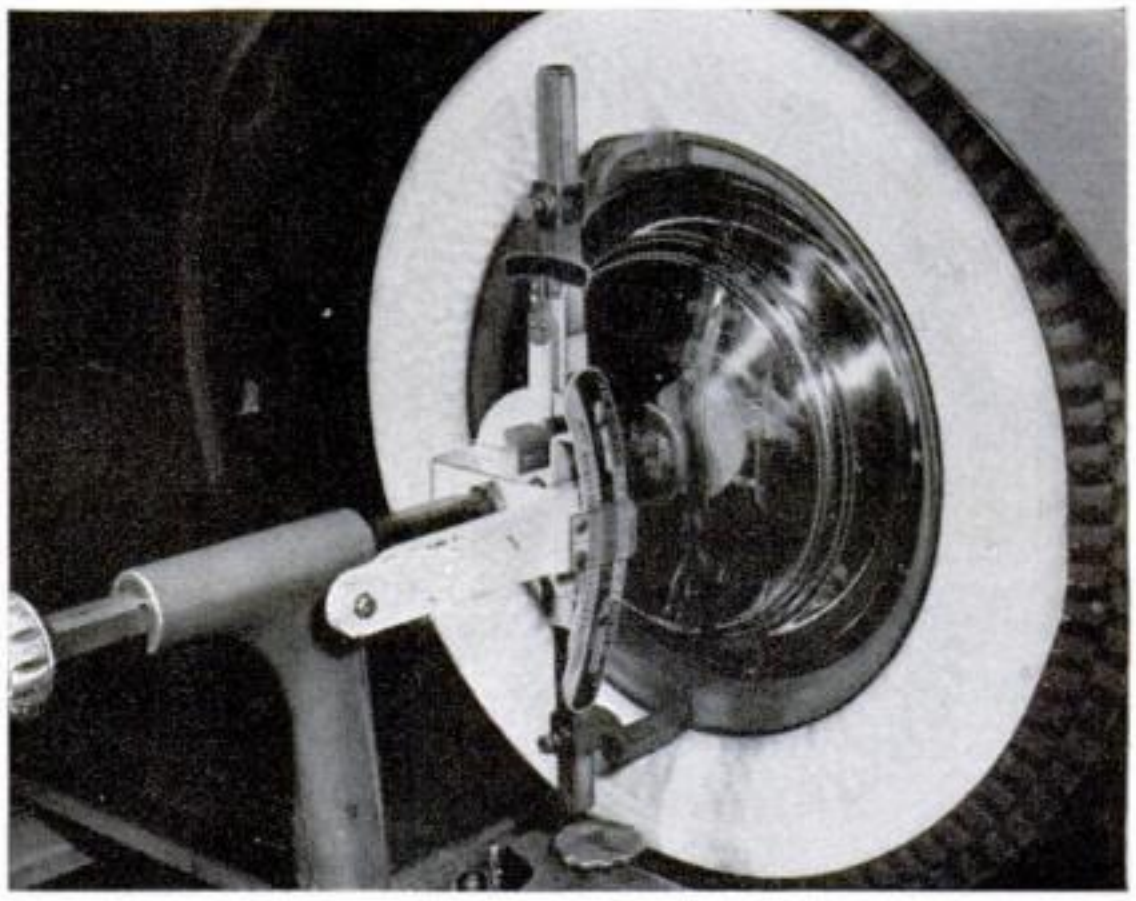
Caster is checked first on the front end, provided no mechanical defect is found. With the wheel turned to the right, the gauge will record the angle of the kingpin tilt

When caster is correct, camber of wheels can be checked, as below. This camber causes a tendency to outward roll, offset by toeing in the wheels

CASTER. This effect, produced by tilting the kingpin as in drawing A, is like that of a furniture caster, or bicycle with steering post inclined so its pivot line strikes ahead of the tire contact. Turning lifts the car; gravity keeps wheels pointing straight



CAMBER. This is a slight tilt of the front wheels outward from vertical to bring the center of tread contact under the center line of the kingpin. To get this without exaggerated tilt, the kingpin tilts in at top, as in B



should be allowed to drive with them much short of perfect.

While toe-in of the front wheels is needed in this geometric problem to conserve tires on the straightaway, toe-out is needed too, on turns, as one of the accompanying drawings shows. This is accomplished to the desired amount for various turning angles by the inward bend of the two steering-knuckle arms to which the tie rod is connected.

There is a wide variety of wheel-misalignment symptoms which the tire and wheel experts can diagnose by tire inspection. But the same experts know that these symptoms can often indicate several possible alignment errors. The more important visual indications of trouble, however, can be used to advantage by any motorist.

Obviously, if wheels toe in too much, the front tires become scuffed by being forced sideways over the pavement. This wear covers the entire tire surface where it touches the road, and generally shows a feather edge on the inward side of the tread blocks. Excessive toe-out causes wear too, but the feathering will show on the outward sides of the tread blocks.

When scuffing shows up on both front and rear tires, improper tracking is indicated. Feathering on rear-tire treads will also suggest that the rear wheels have developed toe-in or toe-out due to a bent axle housing.

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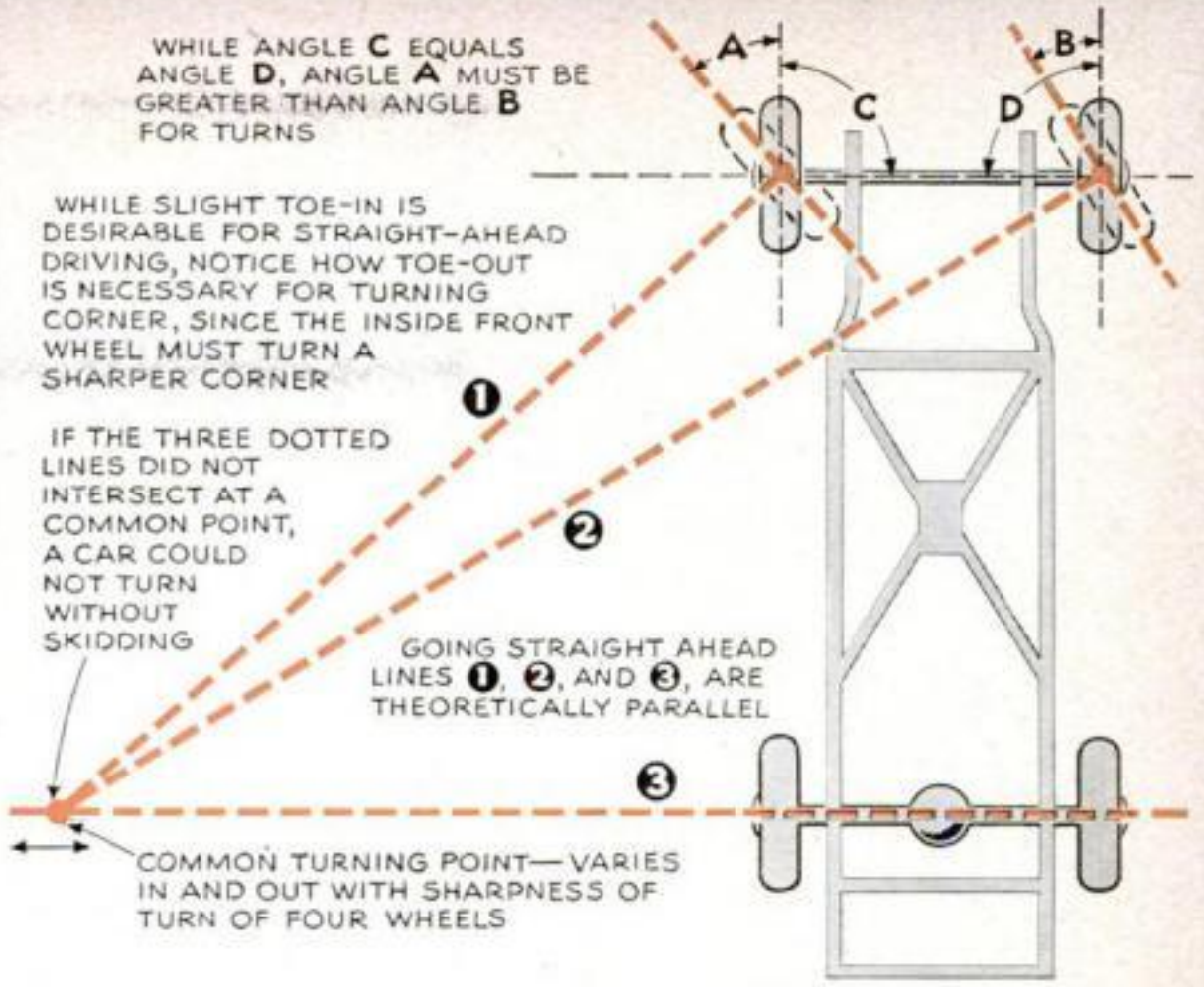
One or more badly worn spots on the tread indicate a tire-wheel assembly that is unbalanced, or a brake drum with a high spot. More serious, they indicate a twisted axle producing unequal caster on the front wheels. As incorrect caster can upset both camber and toe-in angles, the axle may have thrown the whole system out of adjustment. This is particularly true if the cupping is near the tire shoulder. Other cupping causes are underinflation (usually with one shoulder scuffed forward, the other backward), an eccentric wheel, weakened springs, shock-absorber failure, faulty brakes, or improper lubrication.

Underinflation will cause tires to wear out faster on the shoulders, and overinflation will cause excessive wear at the center of the tread. Beyond this, however, the motorist should remember that caster, camber, and toe-in are fixed for a tire of given diameter. Either under- or overinflation changes this diameter, so that even a normally adjusted steering assembly then is unable either to make tires wear longer or make steering easy.

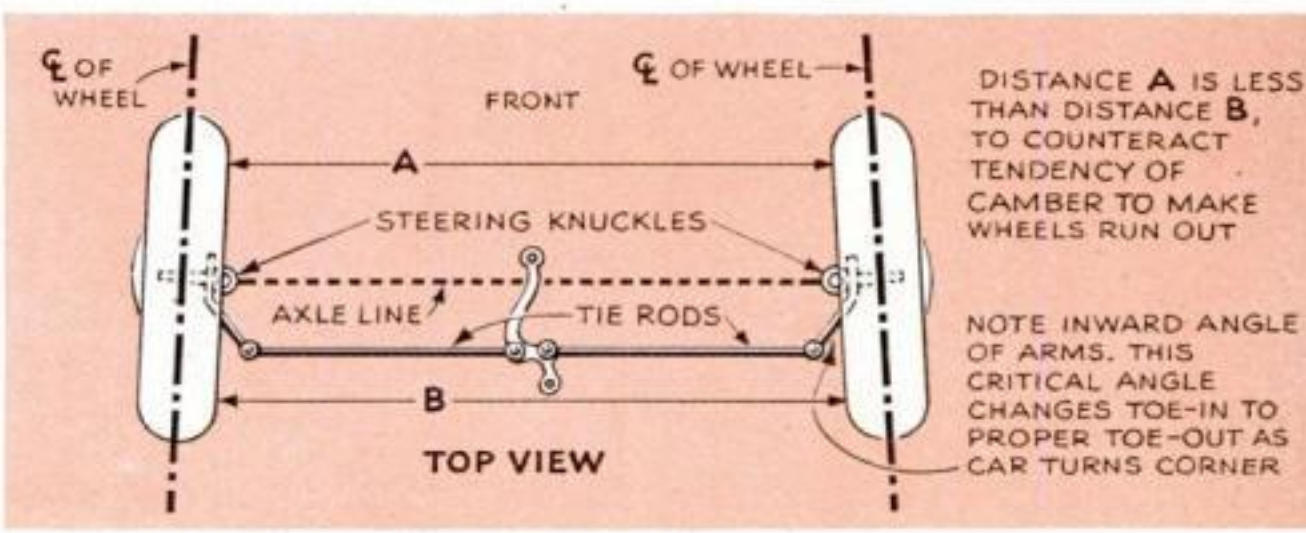
Speed, sudden stops and starts, rounding corners fast, and striking obstacles are the principal remaining detriments to good tire mileage, and any or all of these can by themselves disturb steering alignment in time.

Too few drivers appreciate that the care with which they drive their cars determines how long proper wheel alignment is maintained. Drive carefully, have steering geometry checked every 5,000 miles, and grease your car regularly. Then properly inflated tires will just about take care of themselves.

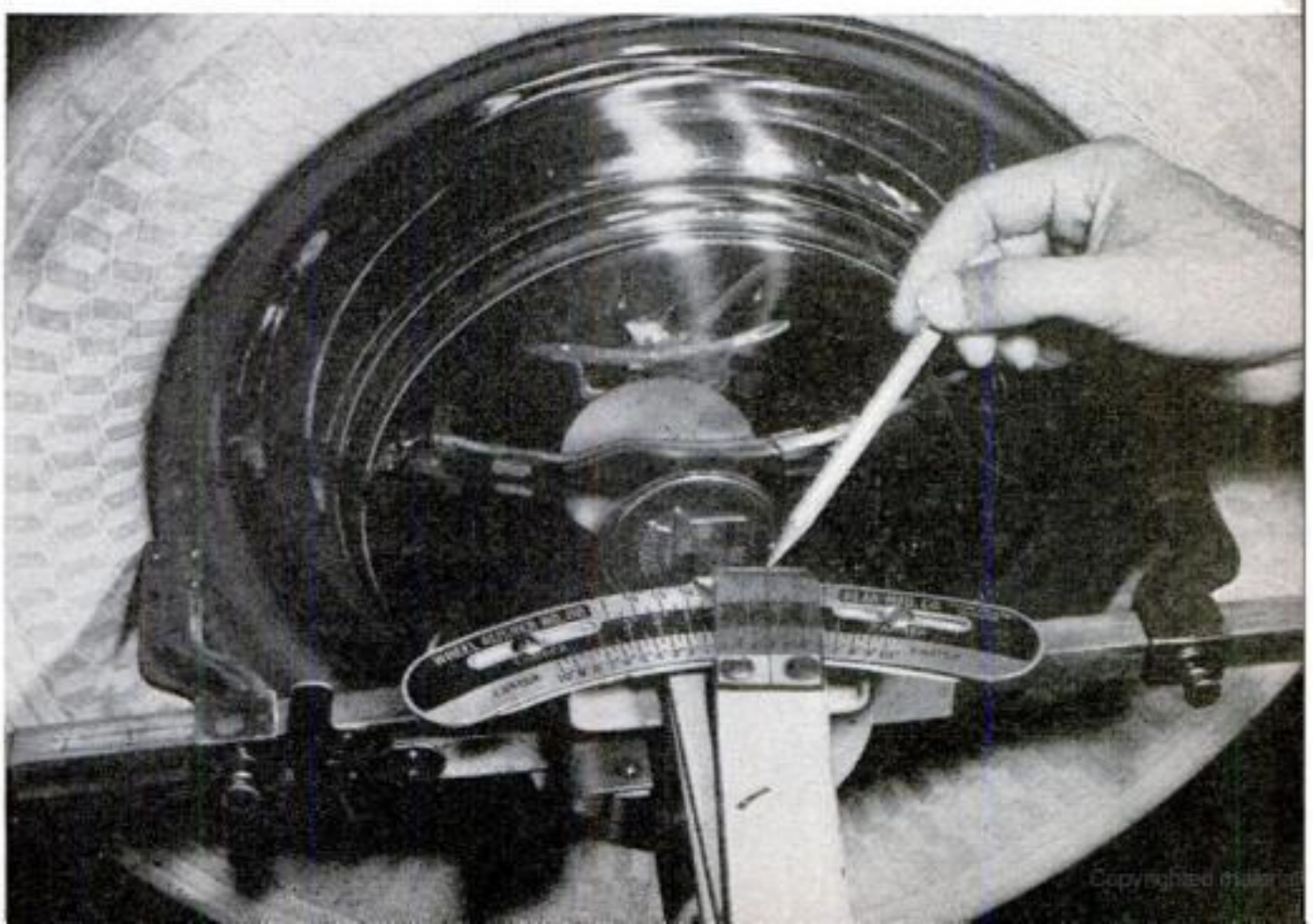
JANUARY, 1943



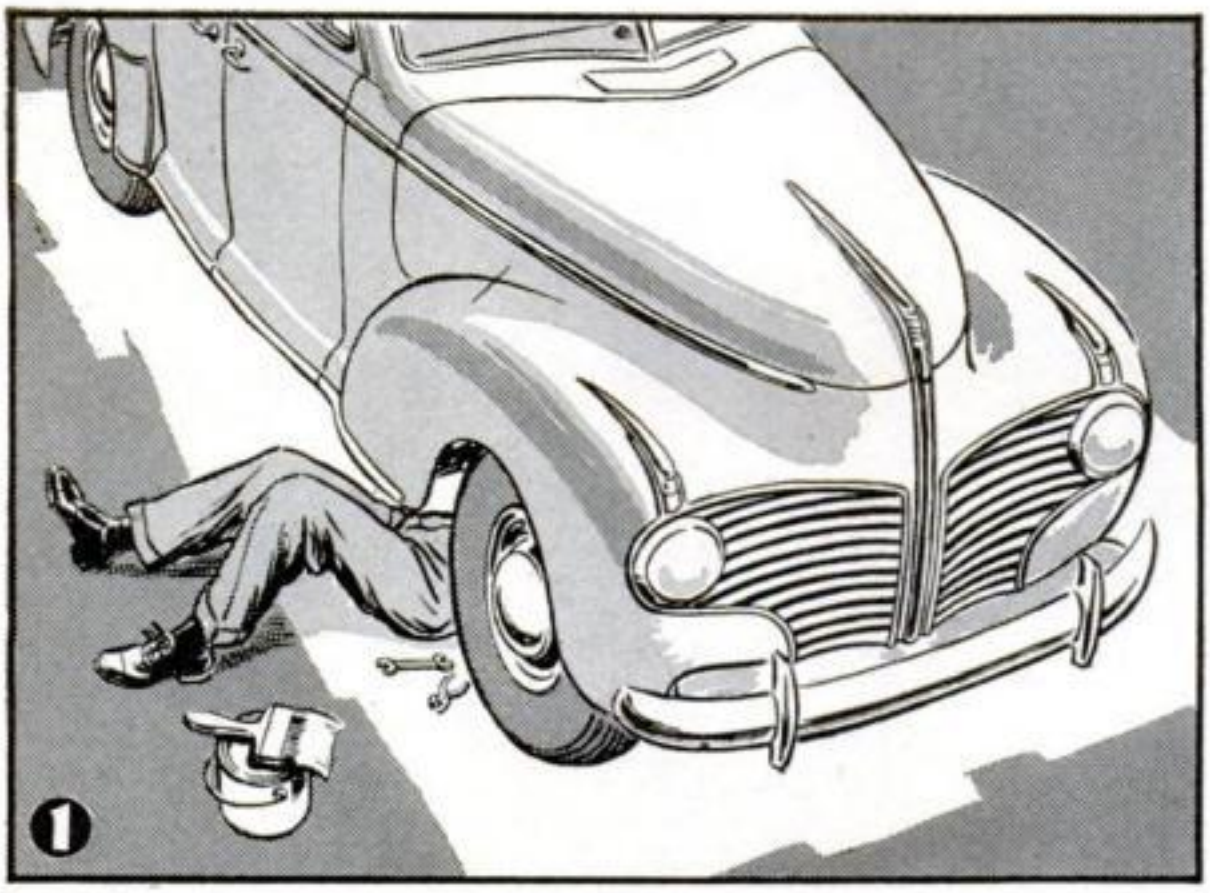
WHY FRONT WHEELS TOE OUT FOR TURNING CORNERS. All must be tangent to their respective concentric circles on a turn. Rear wheels, on a common axle, remain parallel; but the front pair, having different center lines, do not

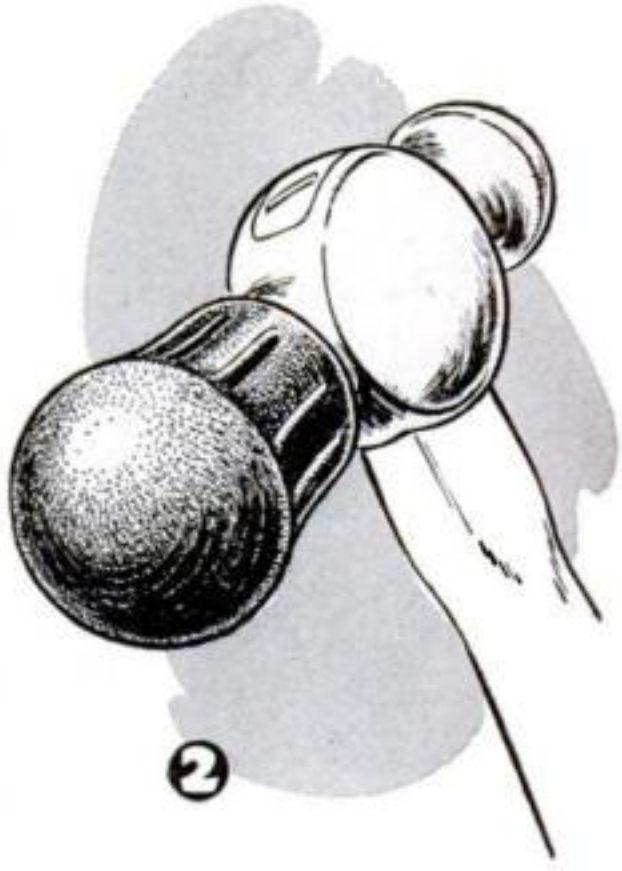


From toe-in on a straightaway to toe-out on turns is accomplished by a slight inward angle of the steering-knuckle arms to which the tie rod is attached. Different angles for the two arms cause the left wheel to turn left more than the right does. Below, checking toe-in



PRACTICAL HINTS



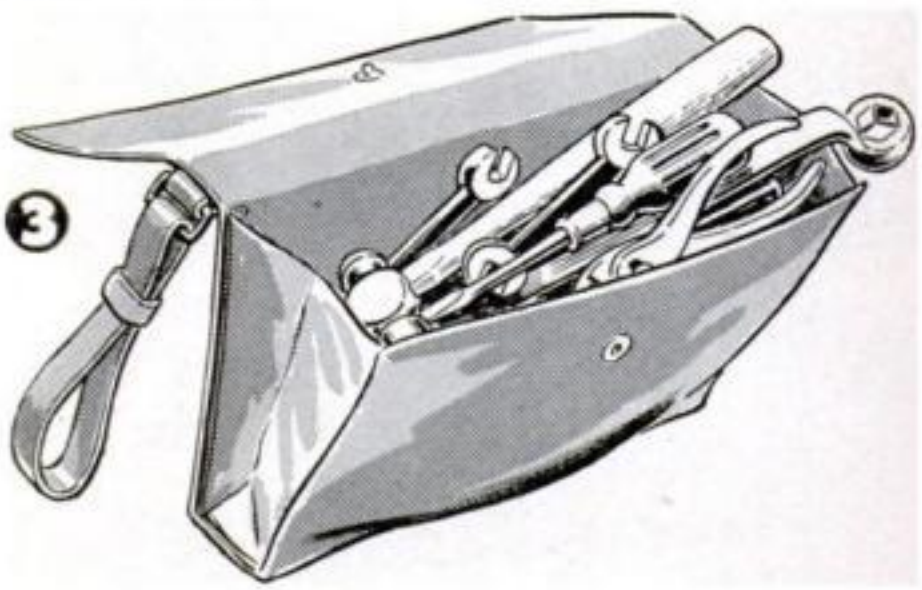


1 WHITE PAINT ON THE GARAGE FLOOR will reflect light upward and be of immeasurable help the next time you have work to do on the underside of your automobile. One mechanic keeps calcimine in the garage, and paints a spot on the floor a little larger than the area covered by the car. By the time he has his tools ready and has pushed the auto over the spot, the calcimine has dried a brilliant white.—A.H.W.

2 TO MAKE YOUR OWN RUBBER MALLET for a useful addition to the tool kit, slip a rubber tip from a crutch or cane over the face of a ball-peen or other hammer. This makes it unnecessary to carry more than one hammer in the kit. Rubber tips are available for a few cents at drug and ten-cent stores and at physicians' supply houses.—R.H.

3 A WOMAN'S PURSE that has been discarded will serve as a handy case for small tools. These pocketbooks, especially the plain, rectangular ones, will hold a surprising number of socket and straight wrenches, screw drivers, pliers, chisels, punches, files, and small hammers. They open wide so that the tools are easy to find.—J.C.H.

4 REVERSING THE HANDLE on the door next to the driver's seat will often save tearing a coat pocket or sleeve when getting in or out of the car, or making hard turns such as in parking in close places. With the handle pointing toward the front, it is pulled back instead of being pushed down to unlatch the door.—A.F.B.



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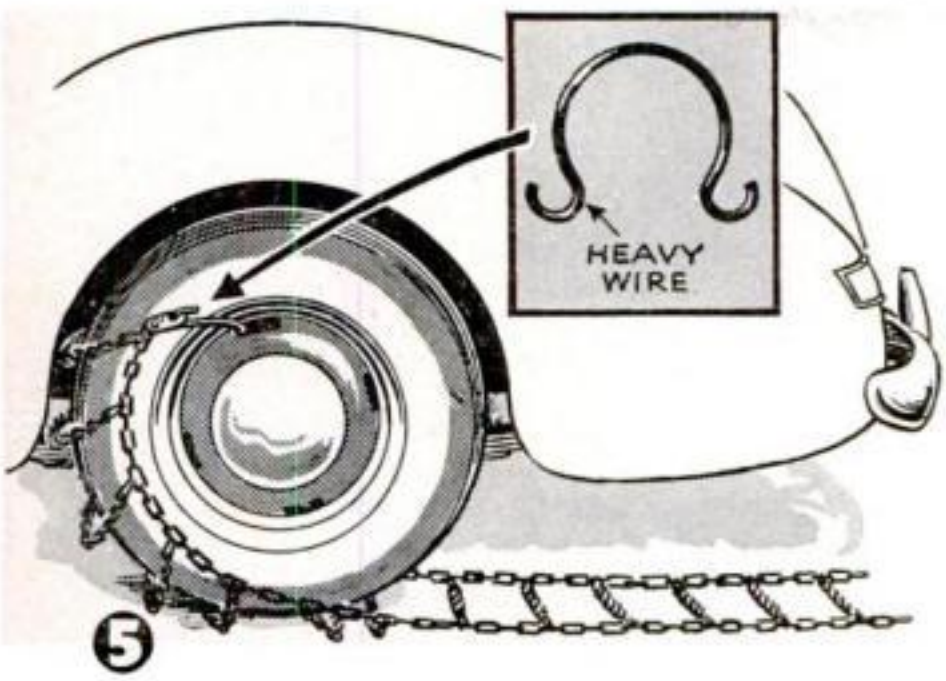
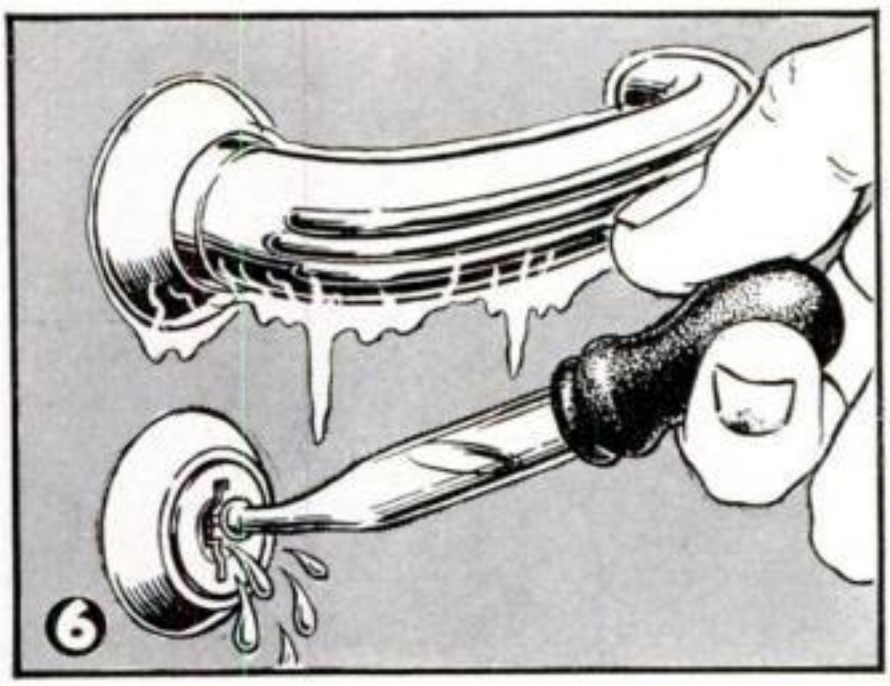
FOR CAR OWNERS



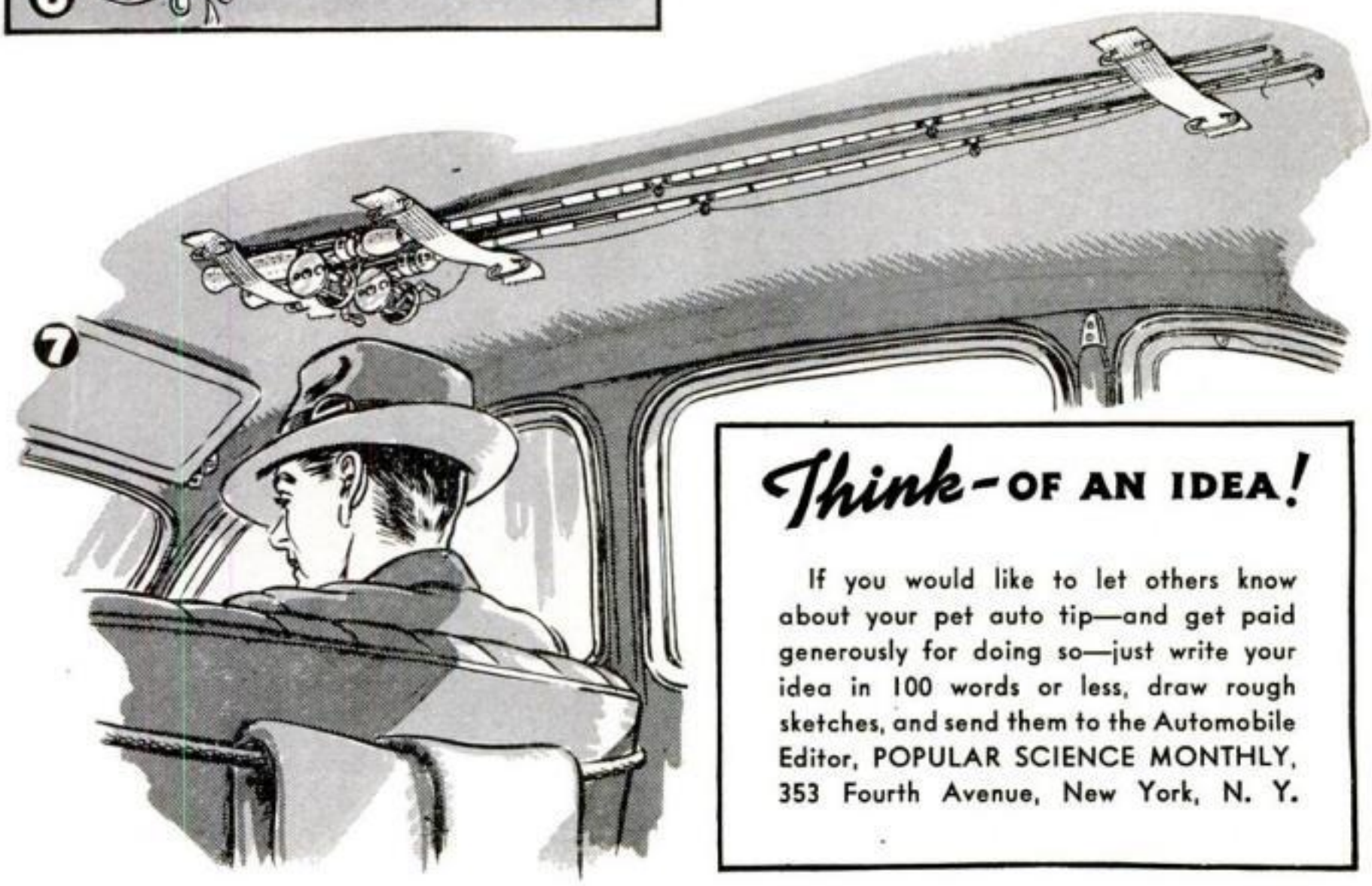
5 **SKID CHAINS GO ON WHEELS EASILY** if one end is attached first to a piece of heavy wire, shaped as shown in the drawing, and the car backed over the chain until the two ends meet. Then it is a simple job to hook the ends together. Put the curved-wire tool through one of the chain-strap openings on the wheel, and remove it after the job has been completed.—J.R.

6 **FREEZING OF A CAR-DOOR LOCK** can be prevented by forcing a small amount of alcohol into the keyhole with an eye dropper. If the lock is already frozen, thaw it first with the warmth of the hand or a match flame. Alcohol containing a rust inhibitor is preferable, and one application should last an entire winter. Be sure not to spill any on the body paint.—H.C.S.

7 **A FISHING-ROD RACK** under the roof of your car can be made in a few minutes with three pieces of stout elastic band and half a dozen safety pins. Pin two of the bands at one end so that the reels will fit between them, and then attach the third at the far end to allow about four inches of the rods to extend beyond it.—B.B.S.



DRAWINGS BY STEWART ROUSE



Think—OF AN IDEA!

If you would like to let others know about your pet auto tip—and get paid generously for doing so—just write your idea in 100 words or less, draw rough sketches, and send them to the Automobile Editor, POPULAR SCIENCE MONTHLY, 353 Fourth Avenue, New York, N. Y.

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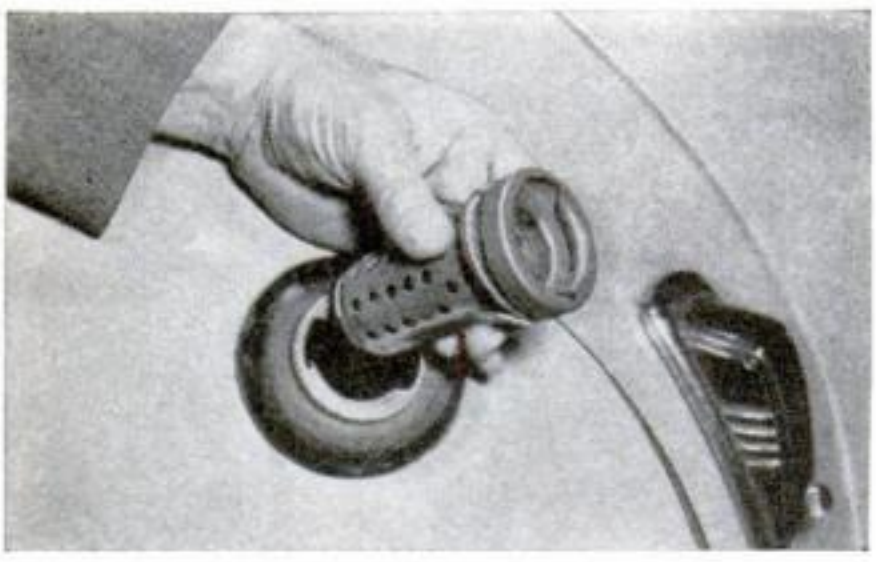
Auto Ideas

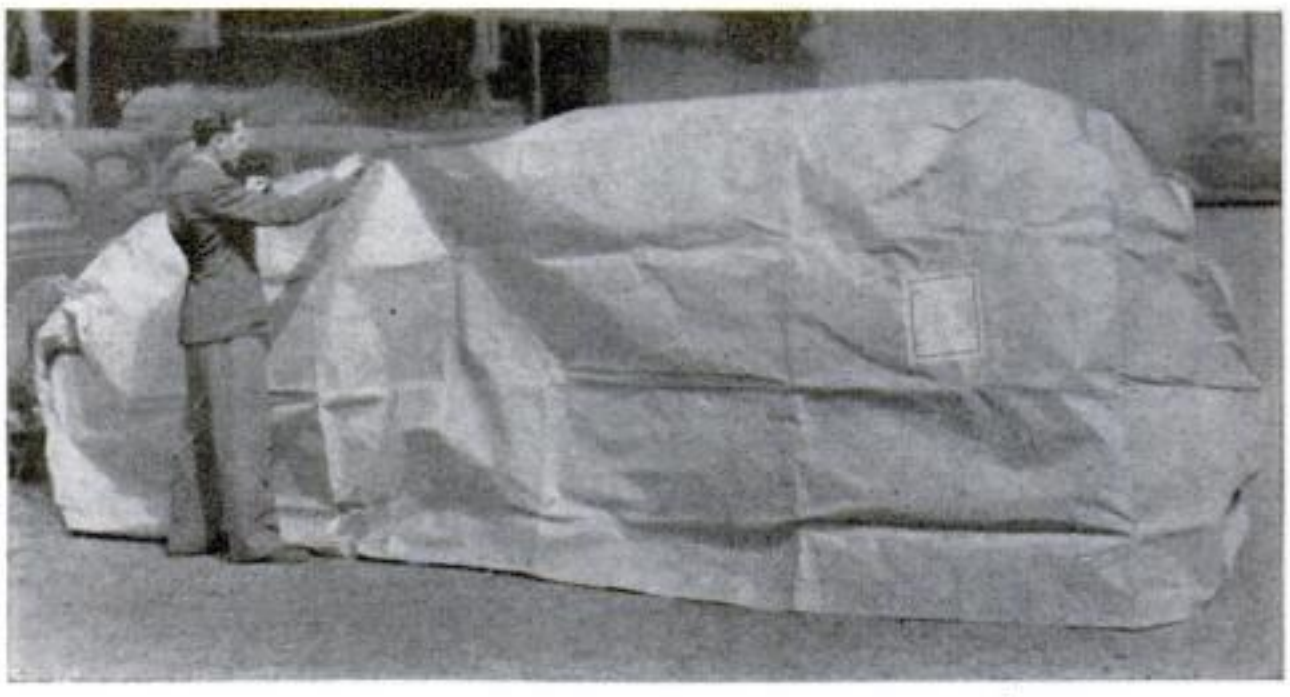
A BRUSH-ON COATING that promises to add to the life of your tires is the latest rubber-conservation device. A paint-like liquid, it penetrates the pores in the surface of the tires, and forms a tough, solid mass without lessening resilience. This application makes a tire 21 percent more resistant to abrasion. After every 500 miles driving, the coating should be renewed. Application takes but a few minutes, and the liquid dries within an hour, but the tires should be thoroughly cleansed first with water. If you have the equipment, you can spray the liquid on with equal effectiveness.

GASOLINE IS PROTECTED from theft with this perforated tube that fits into the filler pipe of a tank and bars insertion of siphons. Its connecting spring wires snap it in place so that it can't be removed during the life of the car. This lock is made so that it will fit any automobile tank.



DIM-OUT MASKS for driving at night in dimmed-out coastal areas are now available for motorists who do not want to paint their headlights black. The masks are really slip covers of black, water-repelling fabric, and contain small slots, as shown above, through which enough light for driving will reach the roadway.

A NEW STORAGE AID—this one for the outside of your car—is a sturdy kraft paper cover that fits completely over the top and sides of the body. This protects the finish from dirt, scratches, and other minor blemishes that occur in even good storage. Before planning to use a paper cover, however, it is advisable to find out whether this method of storage conforms to your local fire ordinances.



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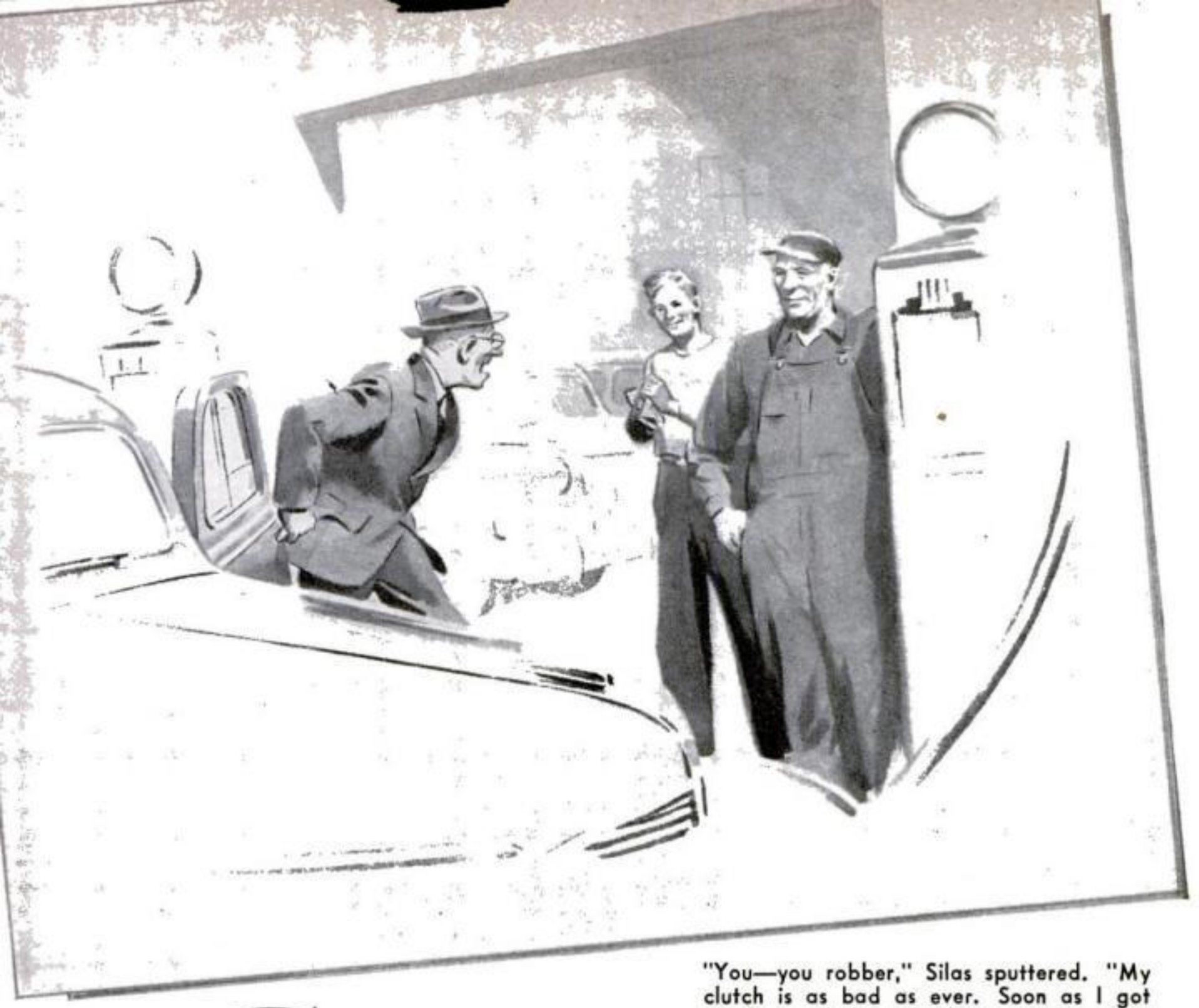

"You—you robber," Silas sputtered. "My clutch is as bad as ever. Soon as I got on the road that whistlin' started again."

GUS listens to CLUTCH CHATTER

By MARTIN BUNN

OLD Silas Barnstable drove his sedan into the Model Garage looking even more than usual like a shopworn bantam rooster. "Gosh dang it, Gus Wilson," he snarled, "my clutch is out of whack again. 'Tain't six months ago I paid good money for you to fix it. I ain't no millionaire, an' I ain't goin' to be hornswoggled. By gosh, you've got to fix this clutch up right without chargin' or I'll—I'll stand you a suit!"

Gus Wilson is one of the very few people in our town who really like Silas, the old skinflint. So instead of losing his temper, he grinned and asked mildly what was wrong.

"I dunno what's wrong—that's your business!" Silas barked. "All I know is that you overhauled it—or said you did—and told me it was as good as new. And now every time I back up, the danged car shakes the liver out of me. An' what's more, around twenty-five that clutch gets a-whistlin' till it sets my teeth on edge. Well, what you goin' to do?"

"Find out what's the matter, first," Gus told him. "Back up as far as the doorway."

Silas started his engine, shifted into reverse, and let in his clutch. As the car moved, it began to chatter and shake. "See there!" he yelled, and put on his brakes.

Gus laughed. "Now put her in low and come forward," he said.

Silas did, and the car moved smoothly.

"One reason why you get that chatter," Gus told him, "is that you keep your foot on the clutch pedal while you're backing—you never let the clutch all the way in. I've

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At thirty, that loud whistling began. "What the dickens is that?" Wally wanted to know

warned you a dozen times that doing that wears out your clutch. But, at that, there's more chatter than there should be. You'd better leave your car here overnight."

"You ain't goin' to have the brass to charge me anythin', are you?" Silas demanded.

"If the trouble is the result of our slipping up on anything when we reconditioned your clutch, we won't charge you a red cent," Gus told him. "But if it's anything else, we'll charge exactly what we'd charge any other customer."

Silas pulled at his lower lip, then assented with an unwilling nod.

Next morning Gus found Wally, the Model Garage's current grease monkey and would-be mechanic, staring at Silas's car with a scowl on his usually grinning face. "What's the matter with that old sourpuss's crate now?" he wanted to know.

"He thinks there's something wrong with his clutch," Gus said, "and I'm inclined to agree, although I'm not so sure as he is. We'll give it a road test. Come along—maybe you can learn something."

They got into Silas's car and headed down the road. The engine ran smoothly, and so did the car. But as soon as Gus speeded up to thirty, the noise of which Silas had complained began—a high-pitched, ear-penetrating whistle. "What the dickens is that?" Wally wanted to know.

"Silas says it comes from the clutch," Gus told him. He eased up to twenty, and the noise stopped. When he increased speed again the noise recommenced, but apparently he didn't pay any further attention to it. "No sign of the clutch slipping, so far," he decided. "The instant I speed up the engine, the car picks up speed. That's a pretty fair test. When your car doesn't run as fast as your engine, it's a good bet that your clutch is slipping—and that you're wasting gasoline and power and putting an unnecessary strain on your engine . . . Let's see, now."

They had descended a short but rather steep decline. At the foot of it Gus stopped the car, shifted into reverse, and backed up the slope. He kept his foot off the clutch pedal, but the car shuddered and shook. "That makes it look as if old Silas was right—but I'm going to try another test."

He drove down the hill again. On a level stretch he stopped, pulled the emergency brake on hard, shifted into low gear, and carefully let in the clutch. The engine stopped suddenly.

Gus nodded. "Thought so," he said. "The clutch is all right. That'll be bad news for Silas—he's going to have a bill to pay."

"How do you know there's nothing the matter?" Wally demanded. "It didn't work right when we backed up that hill."

"Something didn't work right," Gus told him. "But that something *wasn't* the clutch. The test I just made comes close enough to being sure fire. When you put on your brakes, shift into low, and run the engine against the brakes, the engine will keep on turning over if the clutch is slipping, but if the clutch is in really good condition, it will stall the engine."

He started back to the shop. The whistling began again, but he didn't pay any attention.

Wally did some hard thinking. "Say, boss," he asked, "suppose the clutch *had* been making the car shake—what would that have been a sign of?"

"Future trouble," Gus said. "And, generally speaking, trouble not so far in the future. Shudder—that shaking when we backed up the hill—usually, but not always, is caused by the clutch. When it is, it usually is the first warning that the clutch is beginning to slip. If a clutch that has started to slip isn't reconditioned, the pressure plate often warps or heat-cracks, and the inevitable result is grabbing. And a grabbing clutch raises the very dickens. Most often it rips out the splines in the drive shaft and universal joint—I've seen drive shafts with their

BUY WAR SAVINGS BONDS AND STAMPS

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splines completely cut off by a grabbing clutch. Sometimes it will yank the teeth right out of the crown gear—and sometimes it will snap an axle. Reconditioning a bad clutch will lengthen the life of any car—especially its transmission and rear-end parts."

"What makes the clutch shake the car?" Wally asked.

"Well," Gus said, "as a usual thing, shudder—or chatter, as some people call it—is caused by glazed spots on the clutch plate slipping to rougher, less glazed surfaces on the pressure plate. Sometimes it's caused by the springs and release fingers of the pressure plate losing the equal tension they should have. And sometimes it is caused by grease monkeys like you shooting too much grease into the shaft that holds the thrust bearing. A lot of that grease works inside the clutch, so that the plates get covered and slip. When that happens you usually have to put in a new driving plate; you can't wash out enough of the grease to stop the shudder."

"And how about that whistling—what makes that?" Wally persisted.

"Oh—that," Gus said. "We'll have a little fun out of that."

Gus turned into the shop, and drove up on the greasing rack. After checking a few minutes he called Wally.

"Here's the cause of that shudder," he told him. "Take a look under here at those rubber engine mountings. See how soft and worn they are? The transmission mountings are just as bad. They let the engine and transmission sag just enough to cause a slight misalignment that makes the car shudder and shake in reverse, especially going up an incline. It isn't bad yet, but you'd soon get the same shudder going forward when the engine had a hard pull. The answer is new engine and transmission mountings."

The next afternoon Silas walked into the shop looking as if he'd lost his last friend. "Got my car ready?" he growled.

"Sure—it's ready," Gus told him cheerfully.

Silas got into his sedan. "I'm going to try it out before I pay you a cent!" he snarled. "I'm sick and tired of being cheated."

Gus grinned. "Go ahead—give her a run. You'll think you're in a new car."

Silas backed out with no shaking. Wally looked at Gus. "Gosh, boss," he said, "we forgot all about that whistle."

"I didn't," Gus said. "He'll be back, and you'll hear plenty."

He was right. Silas came back, and when he hopped out of his car he was spitting like a tomcat. "You—you robber!" he sputtered. "You ain't fixed my clutch. It's as bad as ever. Soon as I got on the road that whistlin' started again!"

"Whistling?" Gus said. "You're letting your imagination get the best of you, Silas."

"So I'm crazy, am I?" Silas snarled. "It does whistle, I tell you! You come out and hear it for yourself."

"O.K.," Gus agreed. "Joe Clark wants to see you first, though—says it's important."

Joe had been coached to keep Silas busy for five minutes over a faked mistake in a paid bill. The moment the old fellow disappeared in the office, Gus ran to the car. Working fast, he attached a piece of tape across the front and through the center of one of the bars of the radiator grille. When Silas returned, Gus was puffing contentedly at his pipe.

They got into Silas's car and drove down the road. Silas gradually increased speed to twenty-five miles an hour. There was no whistle. Then he went up to thirty-five. Still no whistle.

Gus looked at him, and shook his head. "I told you that you were imagining things," he said.

Silas scowled. "I wasn't imagining nothin'. I heard that whistle plain as the nose on your face. It ain't there now, but I heard it, and I'll hear it again. I ain't paying until I'm sure it ain't comin' back, an' you can put that in your pipe and smoke it!"

"O.K.," Gus told him.

Silas dropped him off at the Model Garage and drove on his way.

"Hey, boss, what was that tape for?" Wally demanded as soon as he saw Gus.

Gus grinned. "To stop that whistling noise," he explained. "It didn't come from the clutch—didn't have anything to do with the clutch. It came from a loose bar in the radiator grille that was vibrating like a fiddle string—that happens quite often on that make of car. Next time Silas brings his bus in I'll fix it permanently with a door spring. Until then, it'll be good for him to have something to wonder about!"

GUS SAYS:

Lots of people want to get places in a hurry, and some of them do. Then again, some get there best by taking their time. That's good to remember in driving a car as well as in life, especially now if you want your tires to keep on taking you where you're going.

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Winter opens a new world to the camera fan. This scene at Barre, Vt., and those following were taken by the author, a New York City professional photographer, lecturer, and salon judge, who retains his interest in amateurs. Here he used Super Plenachrome film at f/11, 1/50 second, and a K2 filter. Print made on Defender glossy

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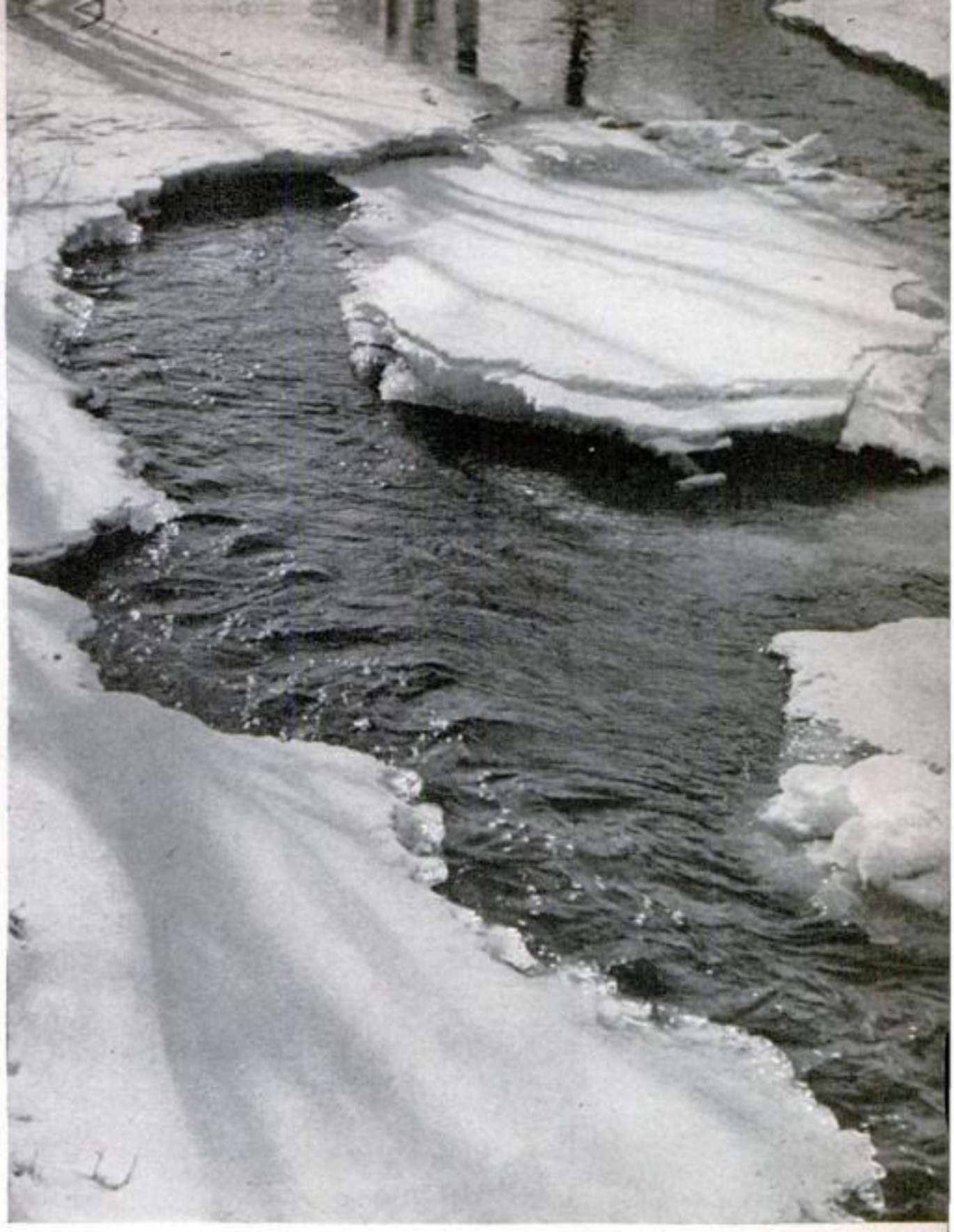
Sparkling Snow Pictures



January, 3 P. M., at Salem, Mass. Here, as for the facing picture, a Super Ikonta B camera was used with orthochromatic film and a K2 filter. This exposure was at f/8, and for 1/50 second

By MAC C. GRAMLICH

SNOW and winter are a photographer's paradise. Blue sky, crisp air, and trees sagging under heavy burdens; roof tops and church steeples white, fences and bridges encrusted, and brooks partly frozen; bundled-up passers-by—these are the rewards. And for the city dweller there are the parks.

The amateur should make plans far in advance for unexpected snow shooting. He should provide warm mittens and watertight boots, for he may be out of doors quite a while. No elaborate equipment is necessary, and any camera may be used. But a few rules must rigidly be enforced for complete success.

First, a correct-fitting lens shade is needed to keep out unwanted reflections of ice and snow. Then, for the tonal qualities, **snow more than any other subject requires a filter. The most commonly used is the medium yellow, or K2, appropriate for either pan or ortho film. It cuts excessive** haze in the middle distance, but exposure time must be doubled or a flat, underexposed negative will result. For dramatic and unusual effects, such as black skies with clouds standing out like cotton tufts, use a red filter, or 23A, and quadruple the exposure, using pan film, of course.

Just what a filter will do is best understood when one knows the characteristics of snow. A snow blanket consists of small particles of frozen crystals. All these individual particles, which appear on your ground glass like grain on the film, must be registered on the plate to get the full feeling, otherwise the print will have that **washed-out effect—too much contrast or just a grayish mass with no detail of textures—that is the most common bane of amateurs.** *(Continued on next page)*

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Central Park in New York City offered this action caught by a 3¼ by 4¼ Graflex at 2 P. M. Super Plenachrome film, used with a K2 filter, was exposed 1/400 second, stopped at f/5.6

Snow itself is almost white, and irregular breaks, such as footprints or tire marks, throw fine shadows. These shadows, however, are actually blue, not black, and without a filter would photograph as white along with the snow. Shadows are usually quite delicate, but through proper technique they can be recorded. Too much stress cannot be put upon the usefulness of a correct filter to avoid a characterless picture of drab emptiness.

In snow photography there is usually little color, therefore orthochromatic film is used generally, although panchromatic may be used as well. A rather slow or medium-fast film is desirable. Latitudes of slow films are greater, and crisp, snappy negatives may be had.

A sturdy tripod will assure sharp negatives and also enable the photographer to stop the lens down and gain greater depth of focus, both in the foreground and in the distance. Many otherwise excellent photographs are disappointing because of a slight motion of the camera during a rather short exposure, commonly noticeable in cold weather when the elements hamper the photographer's aim. It is not advisable to shoot at less than 1/100 second when the camera is not supported on a firm object.

Late afternoon, and the trees in Prospect Park, Brooklyn, cast shadows like this — a picture made with a 9 by 12 Maximar camera, using Super Plenachrome film exposed at f/22, 1/25 second, and K2 filter

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Trudging through the snow at Swampscott, Mass., about 4 P. M. A 4 by 5 Speed Graphic took this view. Super Plenachrome Press film was exposed 1/200 second at f/16, again using a K2 filter

Another type of action, using the same Speed Graphic, Super Plenachrome Press film, and K2 filter. This time the exposure was lengthened to 1/100 second and the lens stopped at f/8 The locale here is Lynn, Mass.

Many boast of being able to secure sharp negatives at 1/10 or even 1/5 second without a support. Perhaps once or twice this may be true, but sooner or later disastrous results will show.

Lighting conditions on snow should be studied carefully. Sunshine is a very important ingredient. Late afternoon, when the shadows begin to stretch, is ideal, for then, if the sunlight crosses the picture from either side, the texture of the snow will stand out in bold relief. Sunlight directly behind the camera has a tendency to flatten out the snow at the cost of detail.

Many excellent photographs accepted by salons were made with no sun visible—pictures portraying mood, such as a snowstorm or misty effects. Handled properly, these pictures resemble etchings. During an actual snowfall, a very slow shutter speed, such as 1/10 or 1/25 second, should be used. These speeds will not freeze the snowflakes in mid-air; they allow them to be seen falling and whirling, and to register on the film as long streaks, not suspended drops. Falling snow is more visible against a dark background such as a building or a street. Care must be taken during a snowstorm to keep the camera from getting wet if it is to stay in good condition.

Exposures are ticklish to judge without a reliable light-measuring instrument. Photoelectric-cell meters simplify the problem, but readings should be taken with great

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care. This is so important that it may spell either complete failure or success. Take readings of the high lights and shadows, compare them, and if a tremendous jump of the needle is noticeable, hold the arm into the sun and take a reading of the ungloved hand. This will give approximately the nearest correct reading.

Most winter scenes have extremes of tone too far apart for all to be recorded accurately at the same time. Exposures against the sun should be doubled, in some instances quadrupled, depending on the position of the sun. Common sense and a knack of handling a meter to its best advantage are necessary. When in doubt concerning a high and low reading, make at least two exposures. If only one can be made under the circumstances, then the lower reading is advisable.

Slight overexposures register the fullest gradations and texture of the snow itself and give detail in the delicate shadows. In these cases development time should be reduced a little to prevent excessive contrast and burnt-up and washed-out high lights.

Winter photography has an enormous field of subject matter, but avoid great contrast, such as unharmonious spots where soil shows through the snow, very dark tree trunks, or any jumbled dark area in the immediate foreground. There are no definite rules on including figures, but human interest will lend itself to almost any subject and in most cases improves the picture.

Skiing, skating, and tobogganing come under the classification of action photography, and call for much higher shutter speeds —1/200 to 1/500 second. Whenever possible watch the action several times —a jumper performing for instance—then focus a bit ahead of the spot where the most unusual is apt to occur. Sunlight and reflections permit stops small enough for a safe margin, and if focusing is incorrect by a few inches, it should not be noticeable except in very large blow-ups.

One more important caution: In sudden changes of temperature, a film will form on the lens, both outside and on the inside or rear element. To avoid failures caused by this, give the camera a gradual change of temperature when going into a warm room or out into the cold. A smart photographer carries his camera close to the body under the overcoat.

If frequent overexposure indicates cold has slowed up the shutter, have it adjusted by a qualified expert.

Salem in late afternoon, using a 4 by 5 Speed Graphic, K2 filter, Isopan film: f/16, 1/100 second

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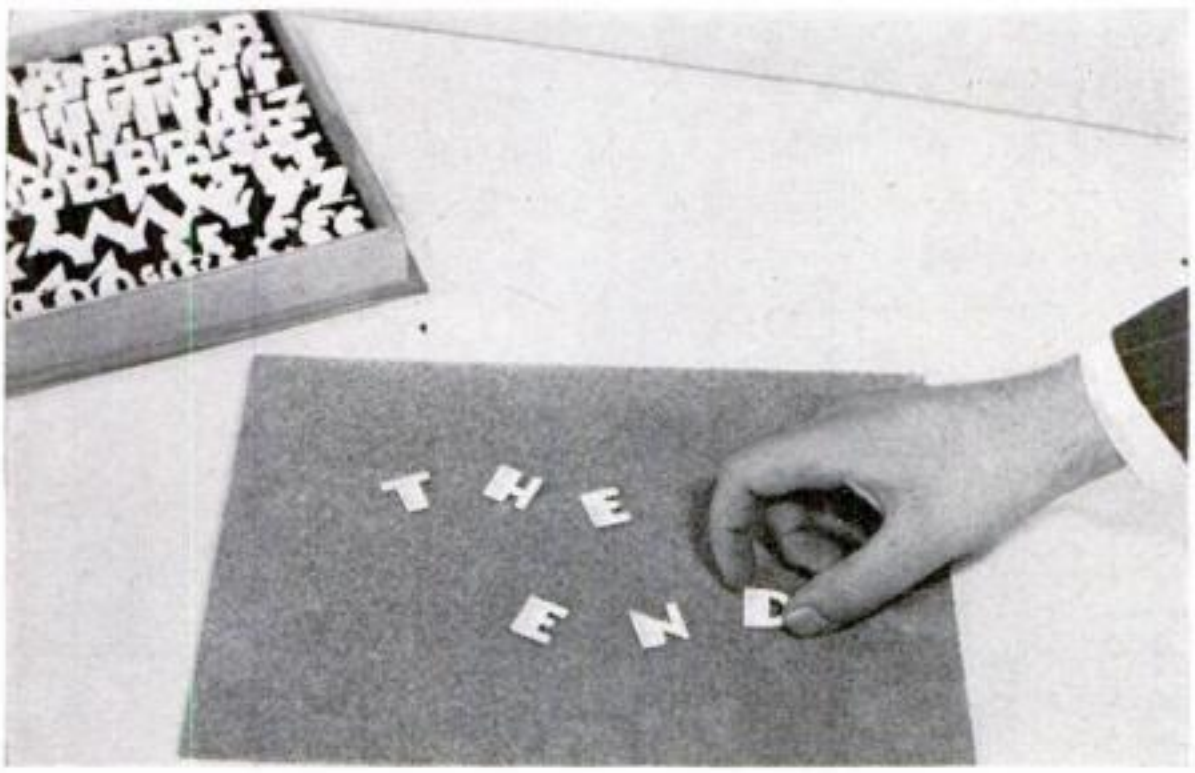
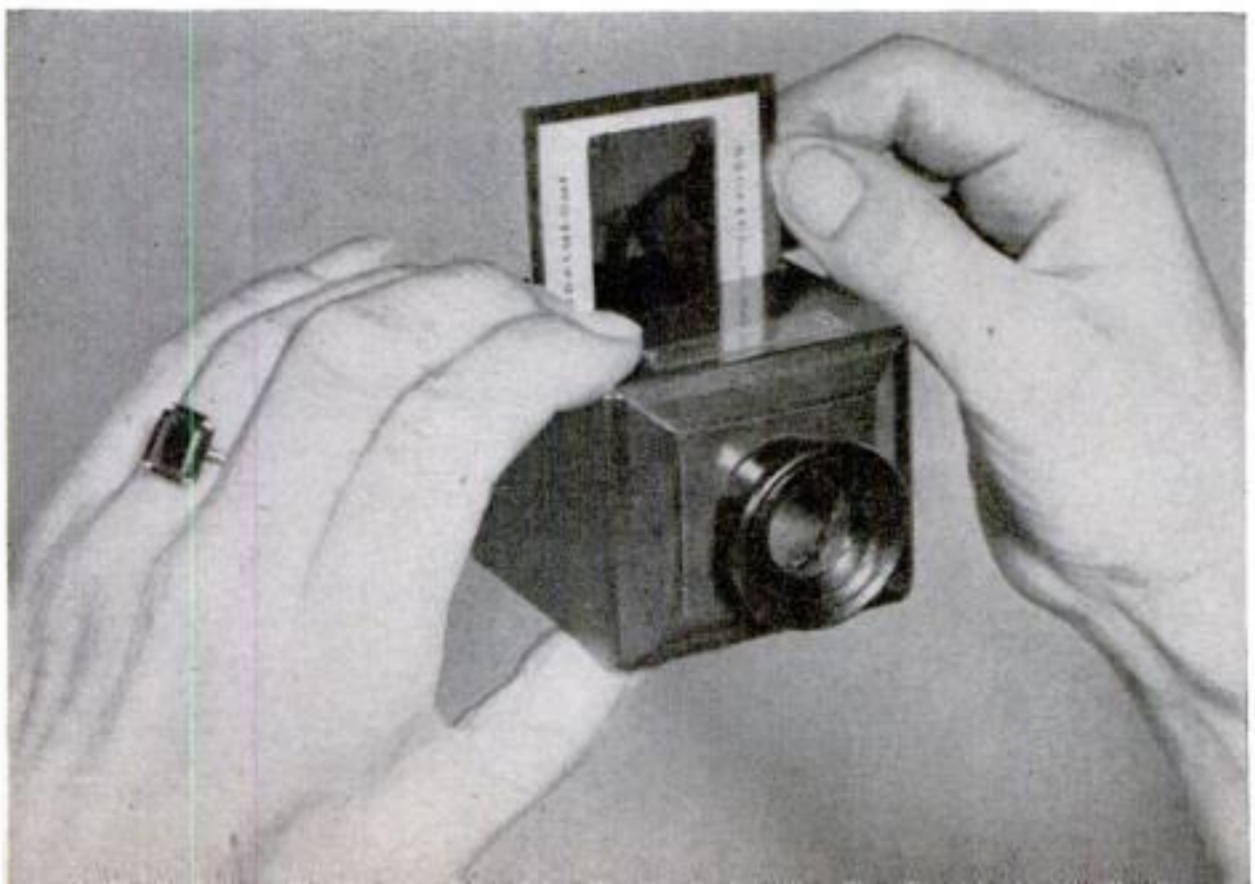
FOR CAMERA USERS

THIS COMPACT CAMERA CASE holds flash gun, spare batteries, reflector, and flash bulbs, in addition to a 35-mm. camera, which is locked in place. Measuring 7" by 9½" by 5½", the case is constructed of three-ply wood, covered with tan leatherette, lined with maroon plush, and equipped with a carrying handle. Hardware and lock are chrome finished. Its sturdy construction will stand a lot of punishment and give the camera good protection.



A NEW TITLING KIT made entirely of nonstrategic materials promises to aid home movie makers. A piece of felt stretched over a wood panel serves as the background. The letters and numbers have thin felt glued to their backs so that they adhere to the background wherever they are placed, much as two brushes will cling to one another if tightly pressed together. The whole kit is housed in a wooden case.



FOR EXAMINING SLIDES, a new viewer has been designed of wholly wood and glass construction. It takes 35-mm. slides and is compact enough to fit into an accessory case or a coat pocket. Its lens, slide, and light source are so well balanced that pictures viewed through it appear to be three-dimensional. The lens is adjustable, insuring accurate focus.

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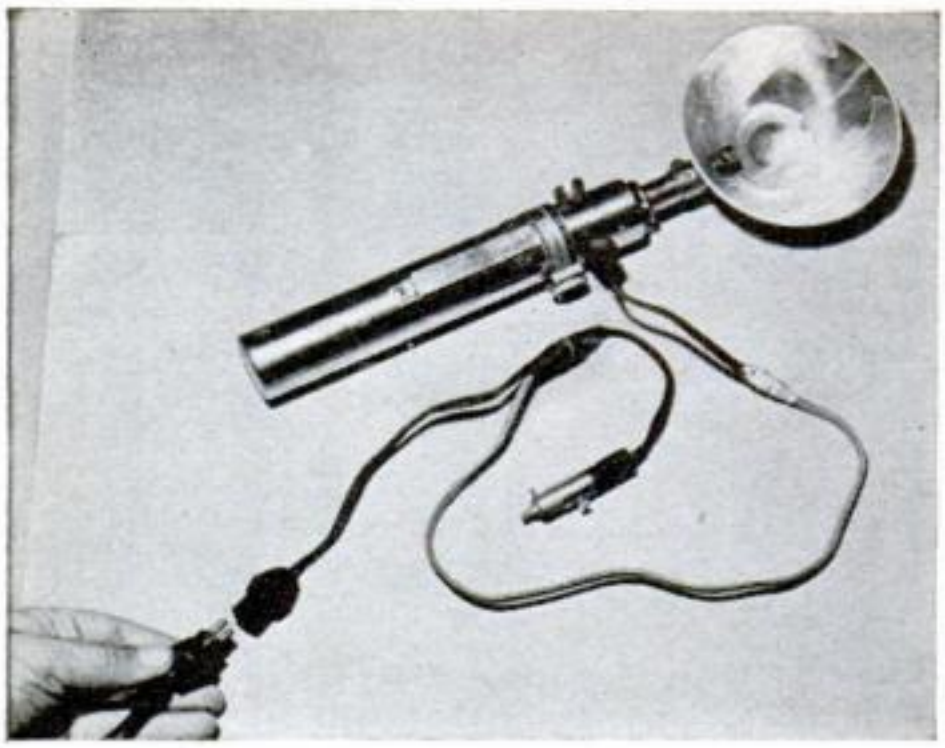
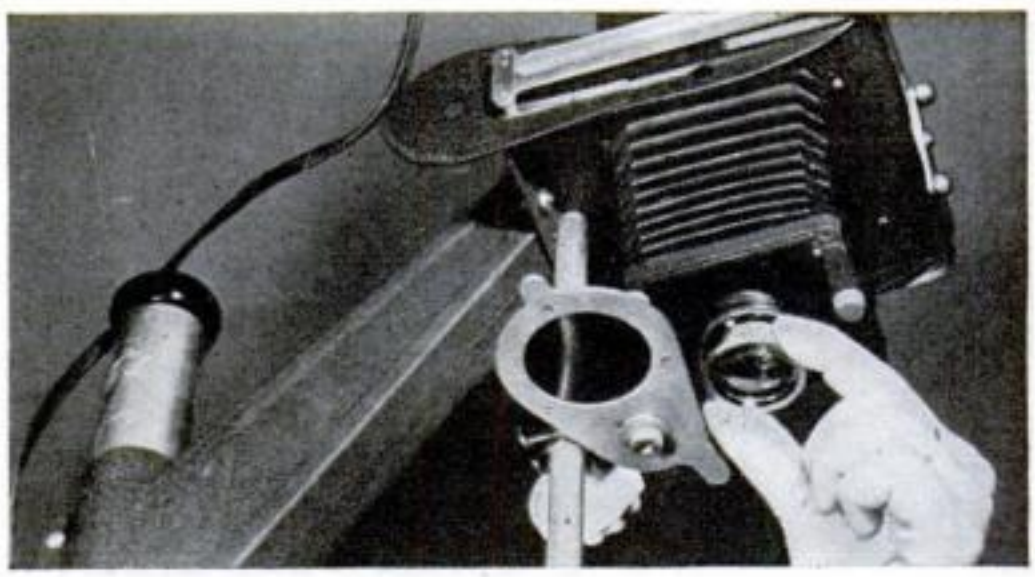


Flash-Gun Cable Extension

DO THE extension outlets on your flash gun accommodate standard electric plugs? If not, you can use an extension by splicing it right into the synchronizer wire, thus equipping the synchronizer plug for double duty. Just splice a short length of wire to the synchronizer lead, and to the free end attach a female radio plug, which is smaller and lighter than standard 110-volt plugs. A male radio plug will connect the extension flash with the plug spliced into the synchronizer lead. This will not affect the synchronization of the gun in any way.

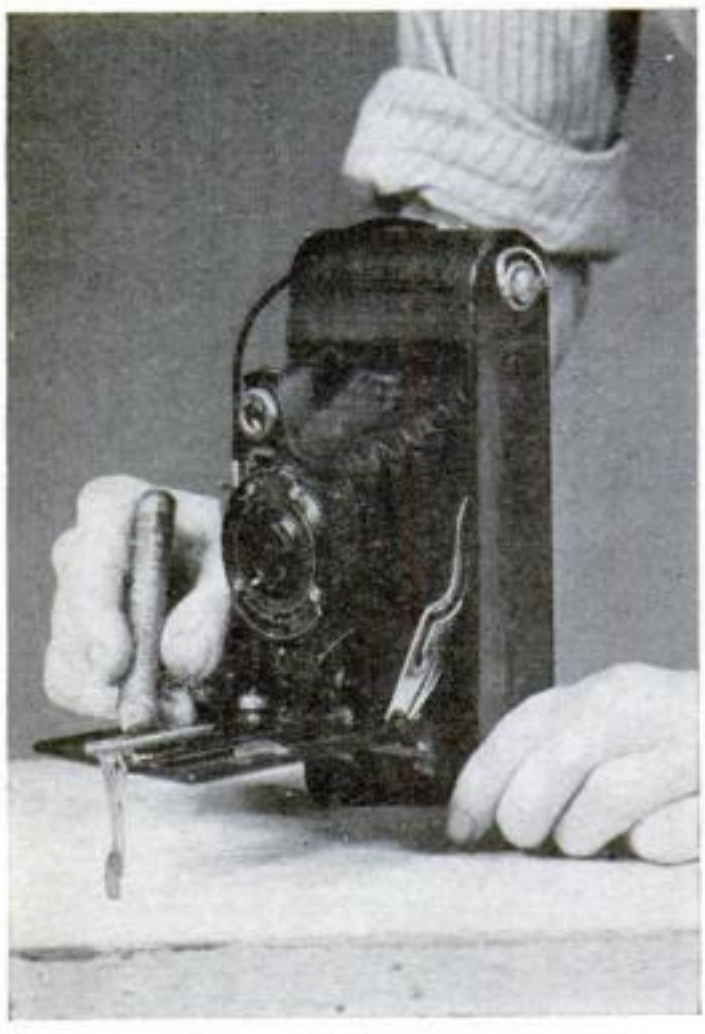
Stick Lubricant Makes Camera Work Freely

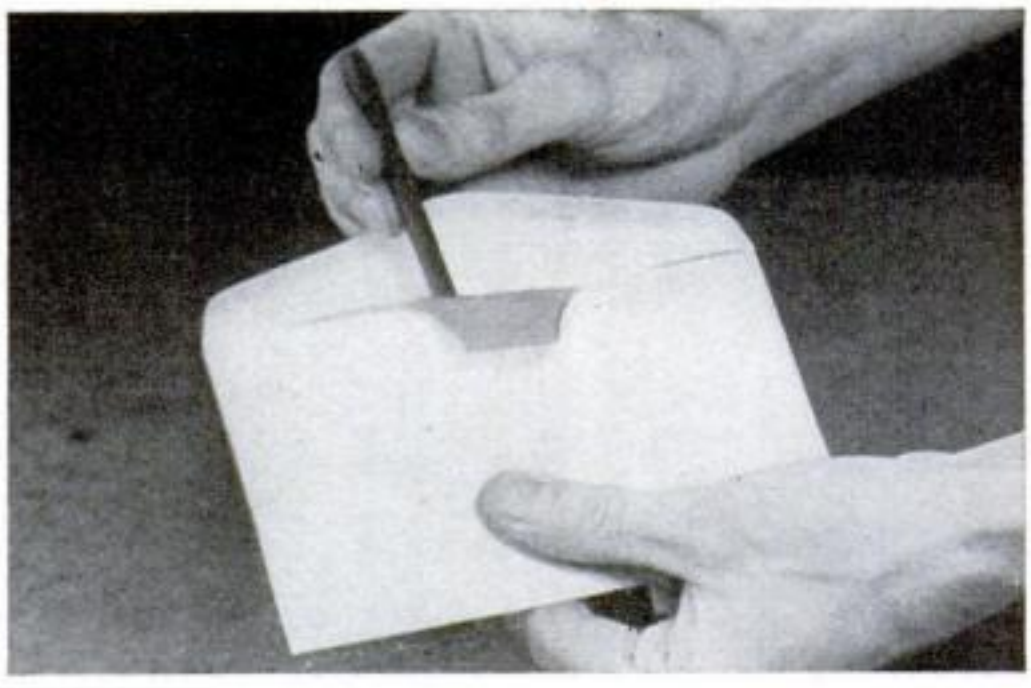
USING oil or grease on a camera is not advisable, but some lubrication on the bellows slide and the slide that locks the back will be found helpful. A good way to provide this is to use a lubricating stick made for taking out squeaks in auto-door hinges. Just a light touch to each side of the bellows guide as shown below will provide sufficient lubrication to allow smooth operation for a long time. The film left by the stick will not soil the hands or clothing, and it protects the metal parts from corrosion.—W. C. WILHITE.



Increasing Size of Enlarger Image

IF GREATER magnification is wanted without raising an enlarger higher from the easel, as in blowing up very small negatives, slip a portrait attachment over the enlarger lens. This shortens its focal length and increases the image size.—LOUIS HOCHMAN.





Sandpaper Points Retouching Pencil

TO KEEP a fine point on your retouching pencil, place a folded sheet of fine sandpaper inside an envelope. Twist the pencil while holding the point from the outside. The scrapings will stay in the envelope.—WILLIAM SWALLOW.

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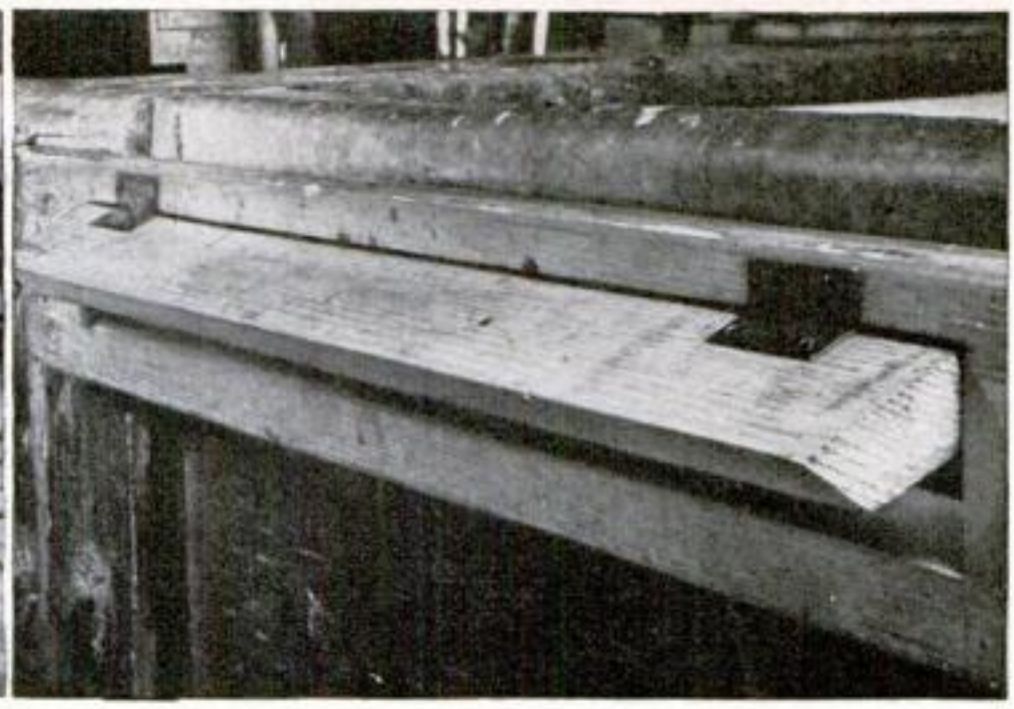
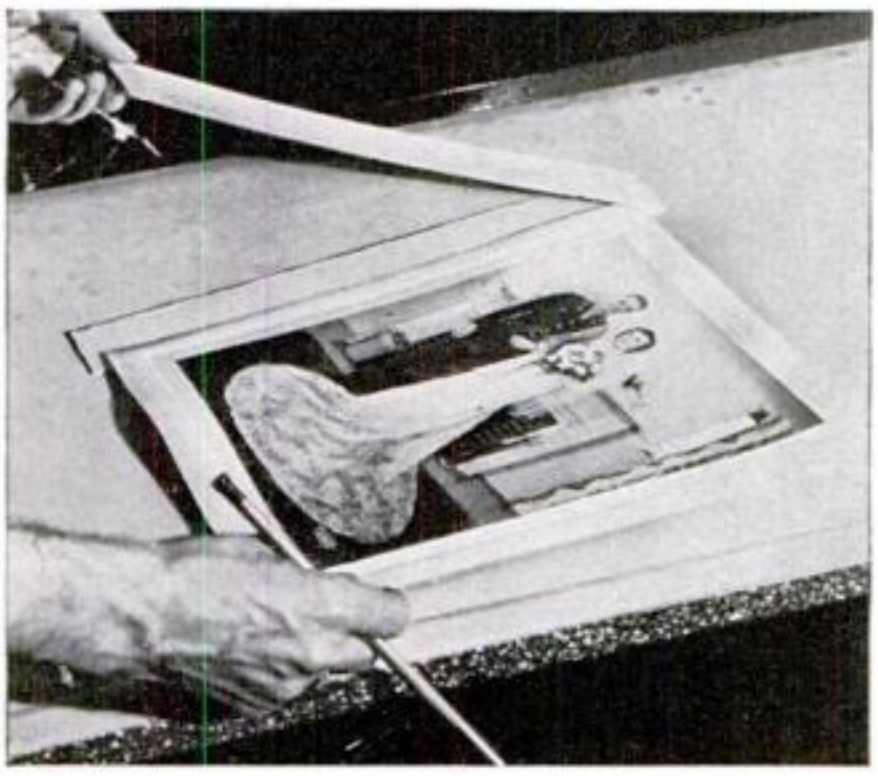


Towel Rack Fastened to Bench Proves Handy in Darkroom

A RACK attached to your darkroom workbench will keep a towel always handy. This rack consists of a piece of wood 1″ by 4″ by 18″, having a rounded top edge, fastened 2″ from the bench with blocks 1″ by 2″ by 4″. A strip 2″ by 16″ is cut out of the center of the rack to be used as a towel locking piece. The lower edge of this strip should be cut at an angle, to exert a wedging action on the towel. It is hinged by the upper edge to the piece from which it was cut, as shown at the right above.

Tuck one end of the towel under the locking strip from behind, closing the strip over it; then bring the towel over the top of the rack and drape it over the front as at the left above. To release it, simply open the hinged piece.—C. H. COLES.



Strips Guide Embossing Tool

AN EASY way to give prints a professional-looking embossed border is to use two strips of heavy cardboard, such as mounting board, to guide the tool. These strips must be slightly longer than the picture, cut perfectly straight, and hinged together with gummed cloth, paper, or cellulose tape at one end. Simply place the photograph between the strips; then hold the upper one tightly against the lower and run an embossing tool firmly along the edge of it to make an indented line. Use a blunt, hard, smooth point.—R. K.

Solution Aids in Spotting

A BRUSH-MOISTENING solution that makes color stick to glossy surfaces will help you in spotting photographs. It consists of one part 1-percent Aerosol or other wetting agent, three parts methanol, and six of water. Saturate your brush with this solution before taking up the water color.

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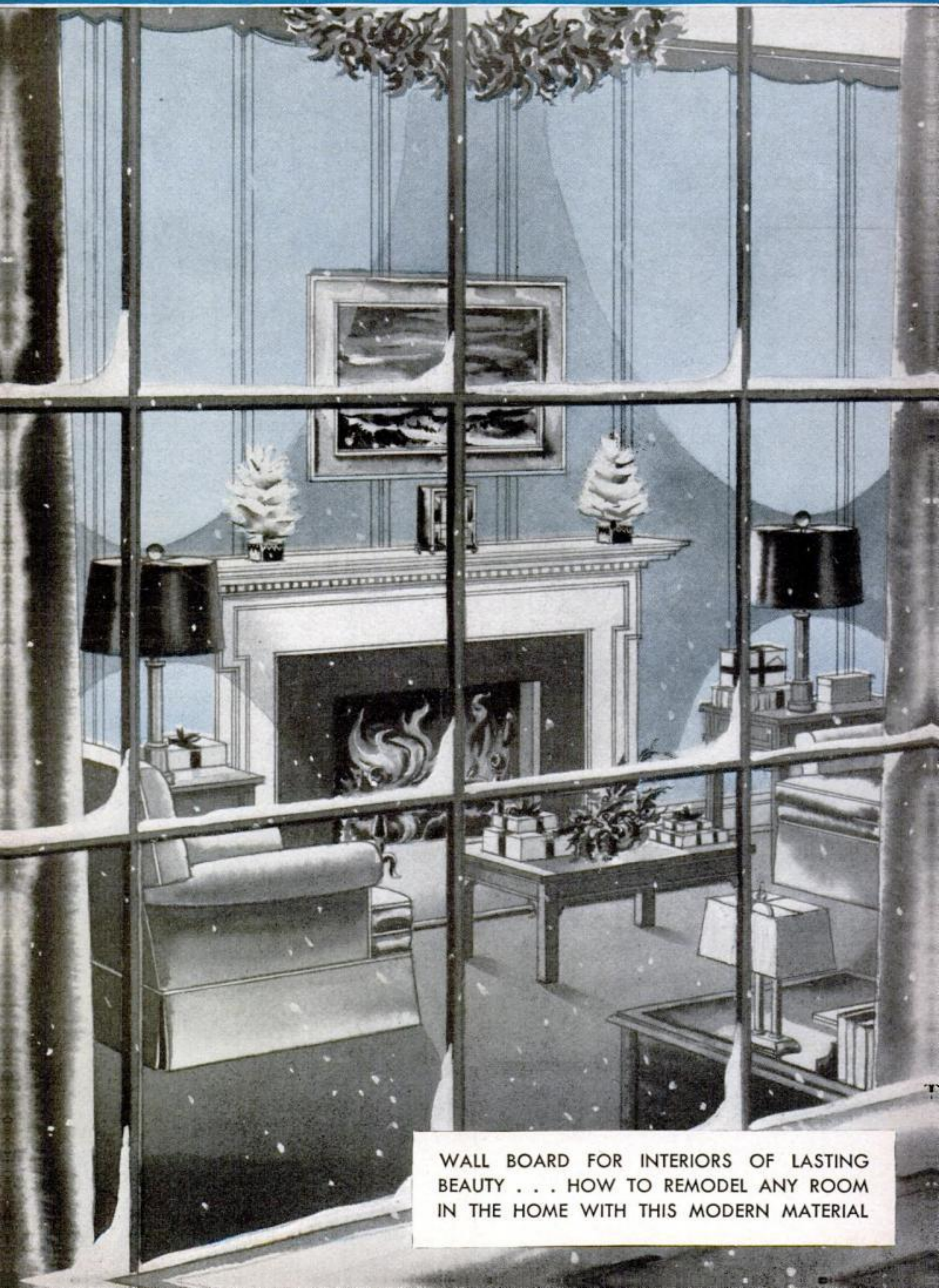
Home and Workshop



WALL BOARD FOR INTERIORS OF LASTING BEAUTY . . . HOW TO REMODEL ANY ROOM IN THE HOME WITH THIS MODERN MATERIAL

Wall Board
for wartime remodeling

By Carl T. Sigman
and William J. Ward, Jr.

IN THE process of keeping your home livable for the period of scarcity ahead . . . or of remodeling it to provide living quarters for war workers, if yours is a defense area . . . or of providing an extra bedroom for your married daughter and her baby while her husband is in uniform, wall board seems almost to be item number one among necessary materials. And with only a few exceptions it is still not subject to priorities, though your dealer may have difficulty in providing you with every type and size.

Also, since you're severely restricted in the amount of money you can spend in remodeling, you need an inexpensive material that you can either use yourself or have applied at low cost. Wall board again is your answer.

It wasn't so long ago that wall board was a sort of stepchild among building materials. It was thought of as good enough only for a child's playroom in the attic, or for a workshop in the basement. But not so today, because American ingenuity has long since set about developing types of wall board to meet almost every conceivable home remodeling demand.

There are wall boards with fine wood finishes to give the effect at low cost of paneled rooms; wall boards with simulated tile designs for bathrooms and kitchens; wall boards that are fire-resistant and provide additional insulation against cold and heat; wall boards that absorb sound or help insulate against it in an ever noisier world; wall boards that can be papered almost at once as compared to plaster, which requires months to set before it can safely be papered.

Nor is wall board any longer exclusively an interior remodeling material. It has gone outdoors, and the dry-built house of wall board, inside and out, over a simple framework, is likely to be the house of the future. Indeed, many such were erected before present restrictions on building went into effect.

In order to make an intelligent choice of wall board for any remodeling job you may have in mind, you should be familiar with the characteristics of the main types. So let's look at them one by one, beginning, quite arbitrarily, with gypsum wall boards. Their chief claim to fame is their fire-resistant property, which is derived from a gypsum core.

For example, ⅜" thick gypsum wall board will withstand the tremendous heat of a house on fire for more than twenty minutes before the framework behind the wall board begins to char. That is often long enough to confine a fire to a single room until the fire department gets on the job.

Both surfaces of gypsum board are made of a heavy fiber material which may be painted or papered. The board comes ¼", ⅜", and ½" thick, in 4′ widths, and in lengths of 4′, 5′, 6′, 7′, 8′, 9′, 10′, 11′, and 12′. It may be nailed and cut like wood.

In fixing over an attic, gypsum wall board may be nailed directly to the studding; or in remodeling a kitchen, for example, it can be nailed either directly over the old plaster, the nails going through the latter into the studding, or to 1" by 2" furring strips previously attached to the wall. Figure 1 shows the size of nails to be used for each thickness of wall board. This chart applies not only to this kind of board, but also to the other types subsequently described. Figure 2 shows how nails are closely spaced around the edges of a panel.

"All right," you'll say. "I can readily see the advantages of gypsum wall board, and I know that it's fairly simple to apply, but what about those joints between the boards?"

Without a doubt, that's the chief problem, and it has been very well solved in several ways.

With all types of wall boards, wood battens or moldings applied vertically or horizontally are used to cover joints and nailheads. Many decorative effects can be achieved in this way. Not many months ago chromium-plated strips were used, but

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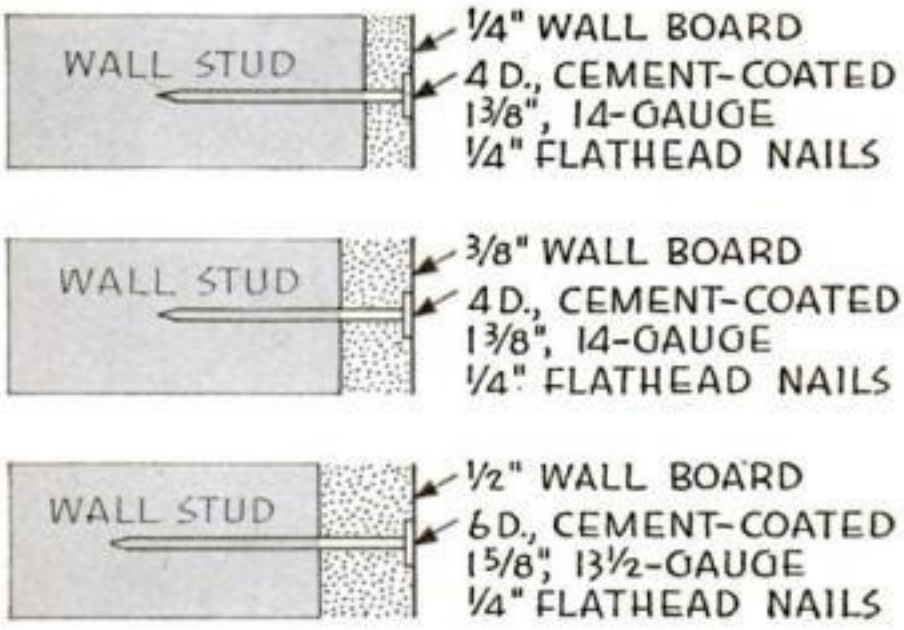
metals for such purposes are very properly out for the duration. Following these both in their own right and as substitutes for metal were colorful plastic battens, but they too have become a luxury unavailable in wartime.

You may be one of those who dislike wall board because you prefer smooth walls for papering or painting. For such understandable tastes, the manufacturers developed the perforated-tape method of covering joints shown in Fig. 3. First, a smooth-working cement plaster especially made for this purpose is mixed and applied with a 5" putty knife. Then the perforated tape is immediately applied and pressed into the plaster. Some of the plaster squeezes through the perforations, and this should next be smoothed over with the putty knife. When this application is dry, another thin coat of the cement is smoothed over the tape so that it can't be seen. Finally, when thoroughly dry, the surface is lightly sanded to remove any roughness that may remain. This same method of covering joints is applicable to the hard wall board still to be described.

Whereas this system can be employed successfully with any type of gypsum wall board, a special type with recessed edges, illustrated in Fig. 3, makes an especially good job. The recess is just deep enough to take the tape and necessary cement, so that the resultant surface will be absolutely flush.

Another cheaper though not so satisfac-



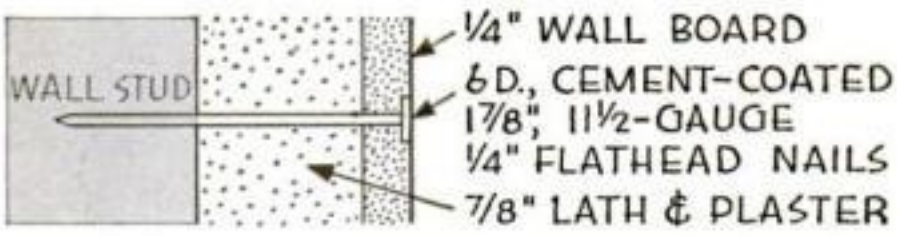


FIG. 1. What sizes of nails to use in fastening wall boards of various thicknesses directly to the studs and over plaster is graphically shown above

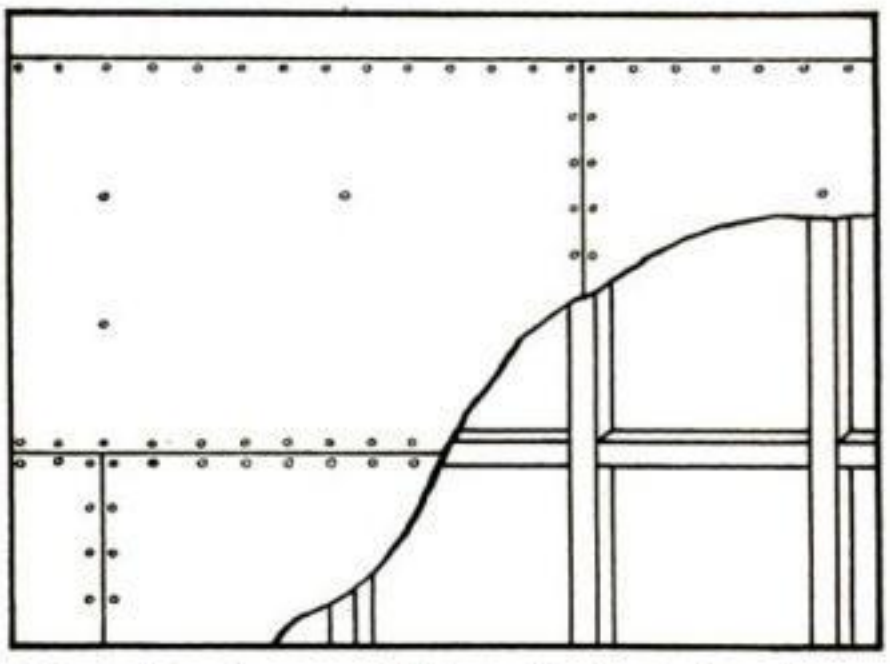
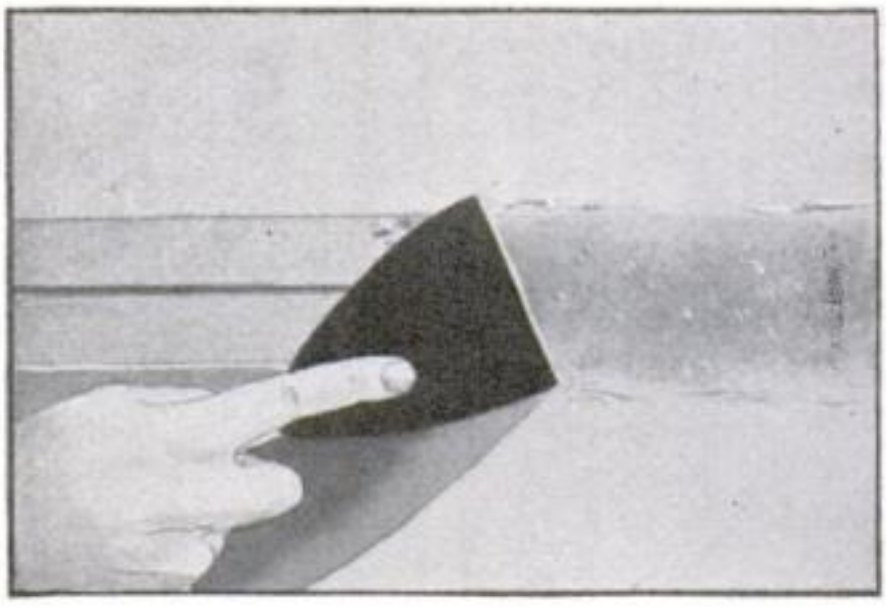
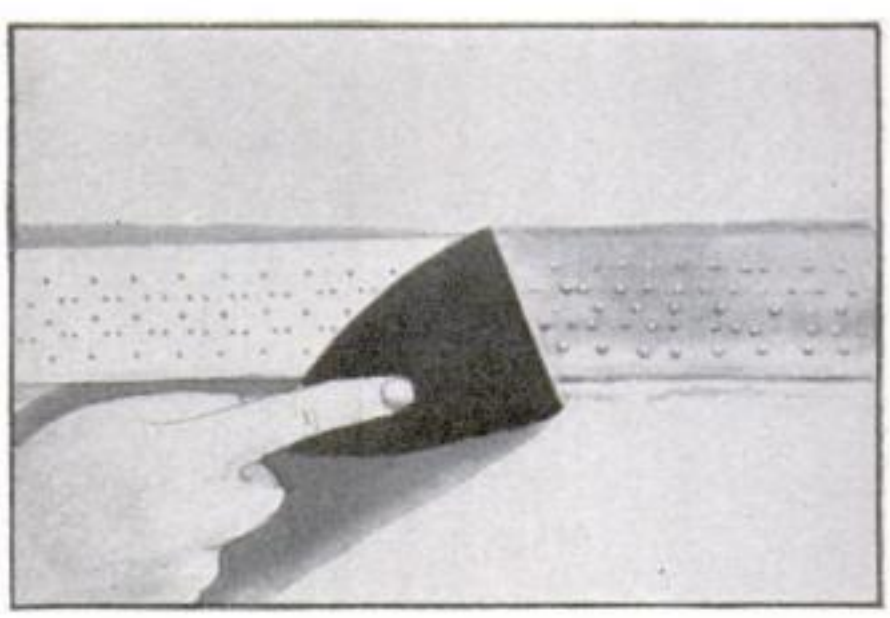


FIG. 2. Panels are nailed on chiefly at the edges. Space nails as recommended for the board you use





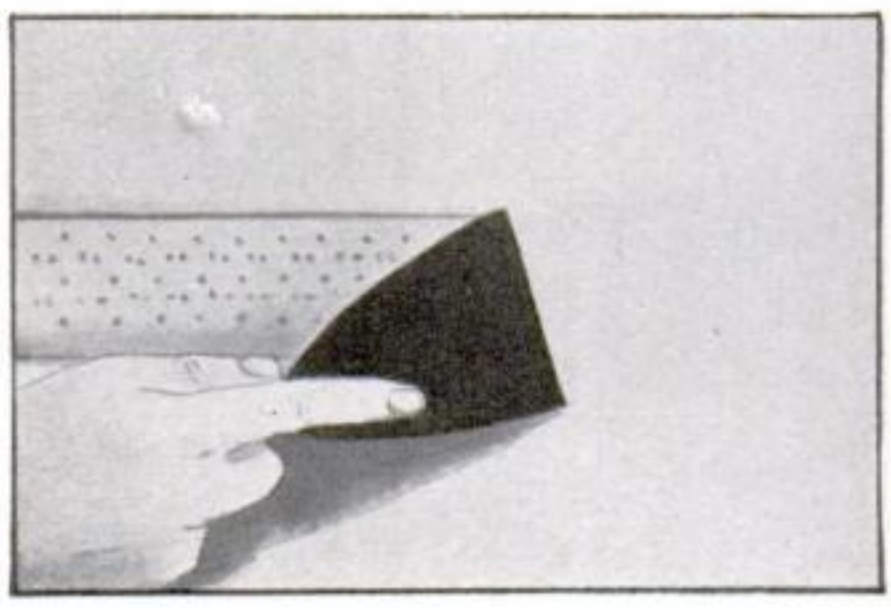


FIG. 3. At right, steps in covering joints by the tape method. Board shown has recessed edges

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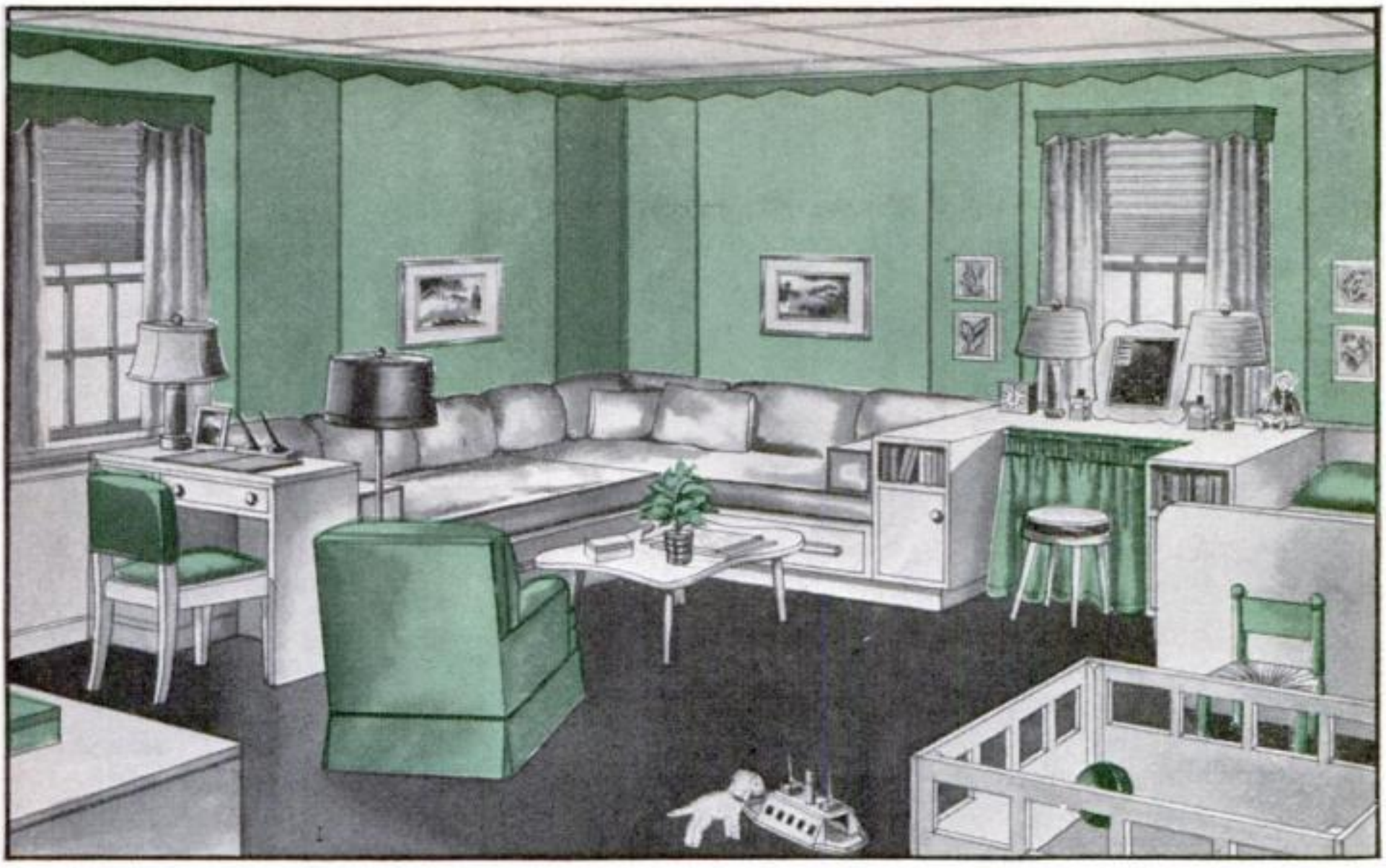

Wall board can be used to make a cozy one-room apartment for a wife and her baby while her husband is in service, with room for him when he's on furlough. Much of the built-in furniture does double duty. Dressing-table and desk lamps also serve as bed lamps. The hard-board ceiling freize is a standard shape

tory method of joint finishing is offered by gypsum-board manufacturers; it is simply a cement applied with the putty knife and smoothed into place.

Where a curve occurs in a wall, use the ¼" thick board; for use around archways, score the inner fiber surface with a saw, making the cuts about 1" apart. The ¼" thick board can then be applied around curves of fairly small radius.

In addition to the plain finish for papering and the simulated 4" tile board for bathrooms and kitchens, gypsum wall board comes in knotty pine, bleached mahogany, and walnut finishes that all but defy detection as a substitute for real and very expensive wood paneling. The wood-grain finished wall boards are made ⅜" thick, 4′ wide, and 6′ to 10′ in length, packaged two to a bundle. Wood-grained wall boards come already lacquered, but their appearance can be improved by additional finishing. Apply a priming coat of clear white shellac and follow with a coat of clear (flat or dull) varnish or emulsified floor wax. The dull varnish finish is particularly recommended. Rub down lightly between coats with steel wool.

Very explicit directions for applying and finishing all wall boards are supplied by the manufacturers; if these instructions are followed, there is little chance of getting anything but entirely satisfactory results.

Before going on to discuss the many other wall boards available, let's take a look at a specific example of what can be done with this versatile material. The drawing on this page shows an interior designed especially to solve a wartime problem—that of a married daughter whose husband is away in uniform, and who with her baby is to live with her parents. This is how her old bedroom might be transformed with wall board to serve as a living room in which she can entertain her friends, a bedroom for herself and her soldier husband when he is home on furlough, and a nursery for the baby. Two built-in beds with drawers below to accommodate bedding serve as sofas by day. The desk by the window to the left doubles as a headboard for the bed in front of it, while the combined bookcase and cabinet becomes a headboard for the other bed. In front of the window to the right is a dressing table.

Any of a number of the good insulation boards to be described, mounted over the old plaster, would help to insulate the noises of the house from the baby, and those of the baby from the house. The insulation board could be used the full height of the room, but it might be better to buy what is called "hard board" for a wainscoting to window-sill height. Short lengths of hard

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board left over from the wainscoting could be used to make the cabinets, dressing table, and curtain valance.

This so-called hard board is perhaps the most familiar member of the wall-board family. It is made from clean wood chips that have been exploded under high-pressure steam and thus reduced to fiber. These fibers are then refined, felted, and pressed in flat-bed hydraulic presses into board form.

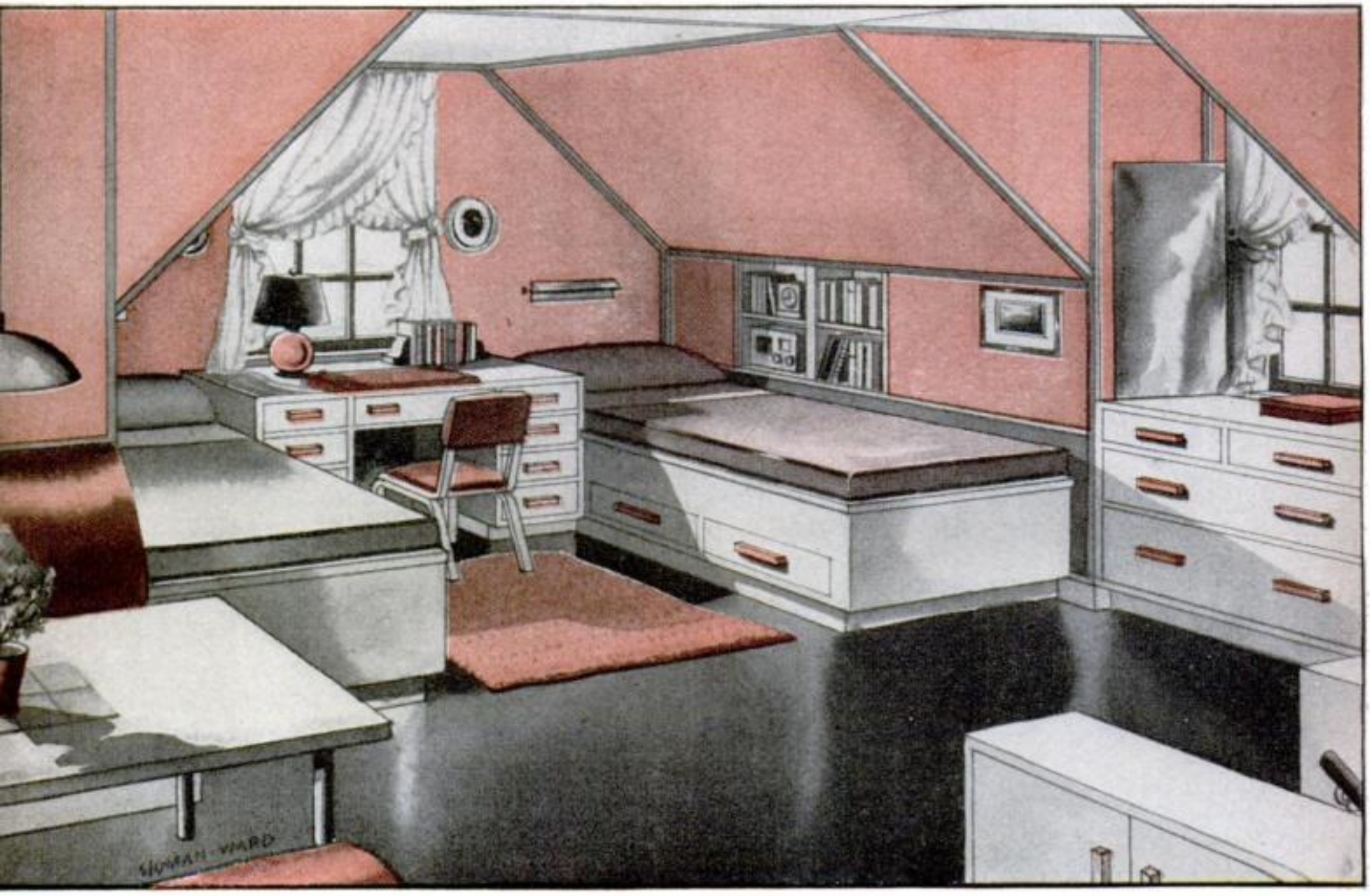
The lignin or natural cement of the wood itself binds the fibers together. By the application of great hydraulic pressure, the degree of density and thickness can be accurately controlled. The resulting board is hard, grainless, free of all imperfections, and absolutely uniform throughout. It is made in thicknesses of 1/10", ⅛", 3/16", ¼", and 5/16", in 4' widths, and in piece lengths from 1' to 12' in 1' increments.

In addition to the usual method of nailing the hard board to the wall, it may be cemented to any solid, flat backing such as plaster or concrete by using a specially prepared mastic spread on about ⅛" thick with a saw-toothed trowel. With this method there are, of course, no nail holes to be covered except those made by the few finishing nails that may be required to hold the wall board in place until the mastic has set. Afterwards these nails can be withdrawn or countersunk.

This method is particularly desirable in mounting over old plaster the hard boards scored to represent 4", 8", and 12" tile. Where such tile board is to be used around bathtubs and showers, it should be carefully scribed and cut to conform to the contours of the bathtub or other fixtures. Then spread Keene's cement along the wall edge of the fixture and force the wall board into it as it is mounted on the wall. All excess cement must be removed before it hardens.

Let's see what can be done to make a livable extra room out of an attic—something you may wish to do if defense plants have mushroomed up in your vicinity and there are more war workers in town than existent housing can properly accommodate. You won't have any trouble getting the necessary priorities on materials for such an improvement and a government loan to finance the undertaking. Probably the income from the extra room will liquidate the debt before the end of the war,

Attic space, turned into a cheerful little apartment like this, can bring the defense-area home owner extra income that will eventually more than pay the cost of improvement. Insulation board is ideal, but hard board can be employed if supplementary insulation is used behind it and at other critical points



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and you will have a finished attic that will not only increase the value of your home, but make it easier to heat in winter and keep it cooler in summer by reason of the extra insulation under the roof.

An attractive treatment for such an attic apartment is shown on the facing page. Insulation board should be used throughout, preferably backed with mineral wool or similar insulation. If you use hard board, it's almost essential to put up a good insulating material behind it—between the rafters, collar beams, and wall studs, as well as between the joists in the attic floor on both sides of the room. Rock wool should also be placed between the studs at the ends of the attic.

In bathrooms and kitchens, it is better to use the so-called "tempered" hard board, which is made by impregnating the ordinary hard board with a special tempering liquid and then polymerizing the liquid by baking. The tempered hard board thus obtained absorbs much less moisture and has much greater transverse and tensile strength, and greater resistance to abrasion, than ordinary hard board. These qualities make the tempered variety admirably suited for use outdoors or where greater strength and resistance to moisture are required.

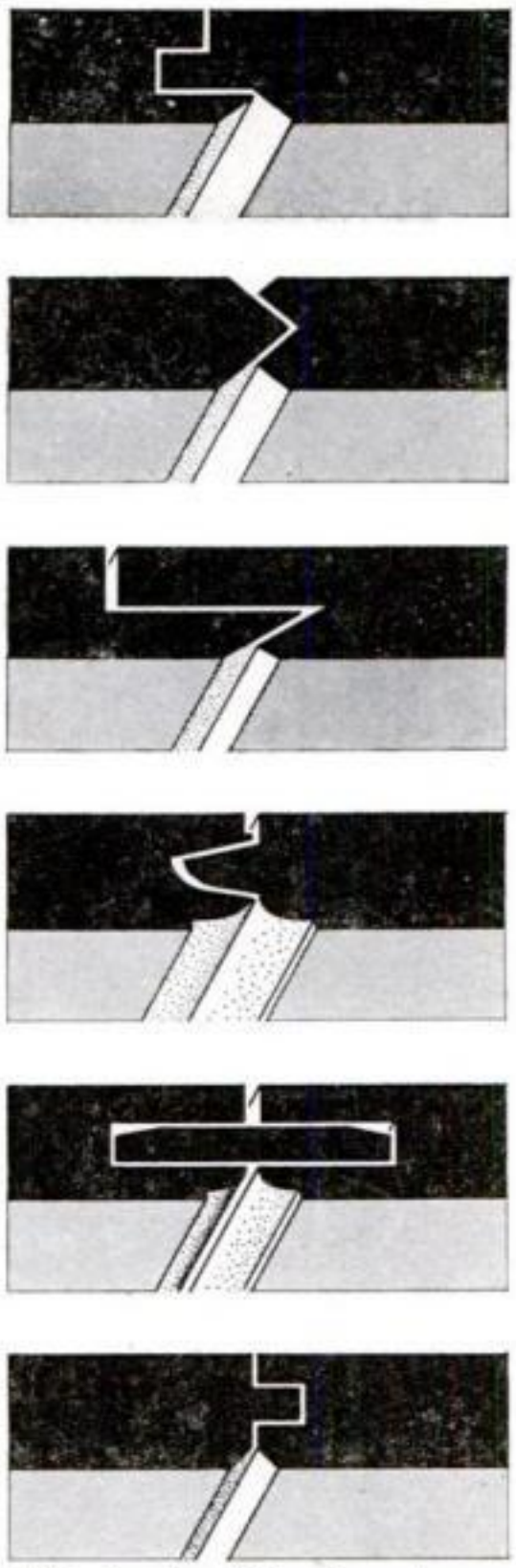

FIG. 4. Insulation boards, as well as tiles and planks, are manufactured with interlocking joints of various kinds. Some typical ones are shown above

Hardwood wall board is an excellent material for kitchen cabinets and shelves, counter and table tops, and the like, because it is smooth and uniform and not readily scratched. It comes in a rich brown color which requires no finish whatever, but if you prefer it colored, it takes paint perfectly and without requiring any priming coat. Before wartime restrictions were in effect, these hard boards were made in green and black as well as the natural brown, and perhaps your lumber dealer may still have some panels in these colors in stock.

One small point may be made in regard to painting the scored tile board. It is easy enough to paint the tile, but not so easy to paint the joint between the tile, which should be done to give the tile a natural look. Simply get yourself a small striping tool or rent one from your wall-board dealer. It makes striping an easy task.

Several manufacturers mount thin veneers of fine woods directly on hard wall board so that you can have the most expensive-looking paneled rooms at considerably less than the cost of solid wood paneling. Such fine woods as mahogany, satinwood, walnut, and zebrawood are to be had, along with about twenty others, in this hardwood veneer paneling, which comes in the following sizes: 4′ by 6′, 6′ by 4′, 4′ by 8′, 4′ by 12′, and 12′ by 4′—the grain running with the second dimension of the panels. Standard thickness is ¼″. These veneer boards can be nailed or screwed to the walls or mounted on perfectly flat surfaces with hard-board mastic.

Also mounted on tempered hard board is a synthetic glazed, stainproof, and acid-resistant surface made particularly for use in bathrooms and kitchens. It comes in a variety of colors with three finishes—plain board, scored to represent tile, and with horizontal striping about 8″ apart.

Still another type of hard wall board is one that isn't a board at all, but is made of asbestos fibers and Portland cement under great pressure into dense monolithic sheets. It is similar to asbestos-cement shingles, hence fireproof, rotproof, and highly resistant to steam and hot water, which makes the material ideal for use in kitchens, bathrooms, and laundries. Asbestos-cement sheets are made plain or scored to resemble tile, and in several colors which never need repainting because the color is mixed into the composition during its manufacture. It comes ⅛″ thick and in 4′ by 4′ and 4′ by 8′ sheets. It can be sawed and nailed just like other types of wall board.

Asbestos-cement board has a waxlike finish that is easily cleaned so that it is well adapted for use as counter and table tops, splash boards, and small kitchen floors. Because it is fireproof, it is a good material

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with which to line furnace rooms and particularly ceilings over furnaces.

The hard boards just discussed are made for use where a strong, hard, easily worked, grainless, moisture-resistant material is required, but where insulation is a secondary consideration, for their insulating qualities are not high. That's why insulation wall boards are becoming increasingly popular in these days of threatened fuel shortages. Tests have shown that such 1″ thick board is equivalent in insulating value to a 15″ brick wall, 3″ of lumber, or 37″ of concrete.

Although manufacturing processes differ somewhat, most insulation wall boards are made from logs of wood stripped of bark. These are reduced to fiber and then knit and pressed together after the individual fibers have been sterilized and waterproofed to render the wood rotproof. In the pressing process, myriads of dead-air cells are enclosed within the wood, which help to give this wall board its high insulating qualities.

This type of board not only saves fuel, but also insulates against sound.

Insulation board is made in three general styles — so-called planks, tiles, and ordinary wall board. Most styles are made ½″, ¾″, and 1″ thick, and a number of styles and sizes are made 1½″ and 2″ thick, but generally on special order only.

Insulation wall boards are made 4′ wide by 6′ to 12′ in length. The so-called "wainscot boards" are 2′, 3′, and 4′ wide by 3′ and 4′ long. Insulation wall-board planks, the more popular style for today's decoration, are 8″, 10″, 12″, and 16″ wide by 6′, 8′, 9′, 10′, and 12′ long. Tiles are 8″ by 8″, 8″ by 16″, 12″ by 12″, 12″ by 24″, 16″ by 16″, 16″ by 32″, and 24″ by 24″.

Most insulation tile, planks, and boards have tongue-and-groove edges to permit concealed nailing and to allow for expansion and contraction without buckling. In Fig. 4 are shown several types of standard joints.

Planks, tile, and boards can be used together or separately. Planks can be nailed to the wall or studding, horizontally or vertically. A single width of plank may be used in a room to give a uniform line, or several widths to give the effect of random-width board paneling. Figure 5 shows some of one manufacturer's suggested wall and ceiling patterns. Planks and tile as well as the board come in various shades of tan and gray, in oyster white, and in a few colors.

Often insulation board is combined with hard board in a single room. For example, in a child's room or the combination living room and nursery suggested on page HW 451, where the wall up to the wainscot height may be subjected to rough usage, the hard board, which resists abrasion, may be used, with vertical planks of insulation board applied above a decorative wainscot molding.

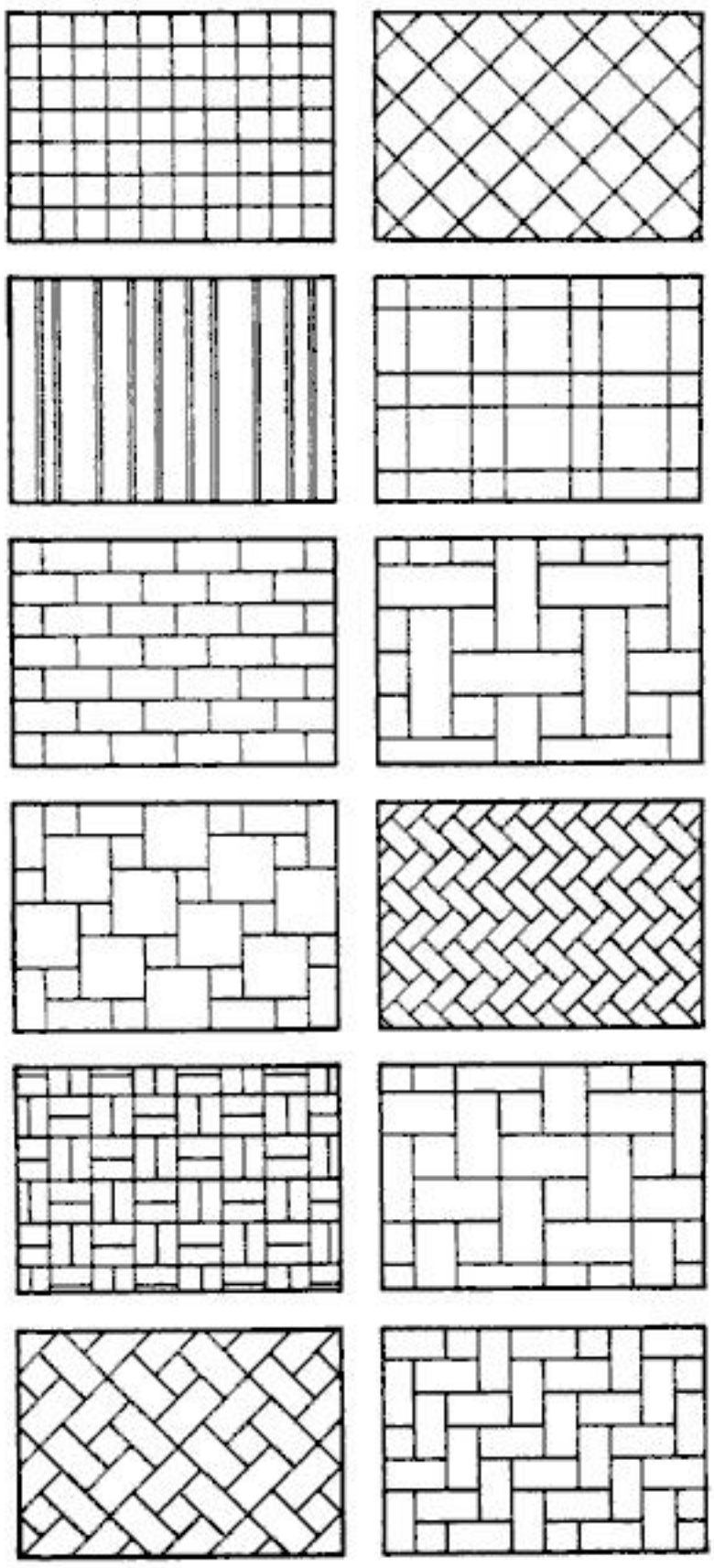

FIG. 5. Planks and tiles of various sizes can be arranged to give a number of interesting effects for modern interiors. These are some of the patterns suggested by one manufacturer

In addition to the insulating wall boards made from wood fibers, a very similar type is fabricated from the fibers of sugar cane. These fibers are closely meshed and felted and then pressed into uniform boards which, like those of wood, can be sawed, nailed, and readily painted. The boards are treated to prevent deterioration.

No discussion of wall board would be complete without mentioning plywood, which is an excellent material for all sorts of remodeling, but the less expensive wallboard grades are no longer obtainable for domestic use—unless your dealer happens still to have some left —because of the many uses to which it has been put in war work.

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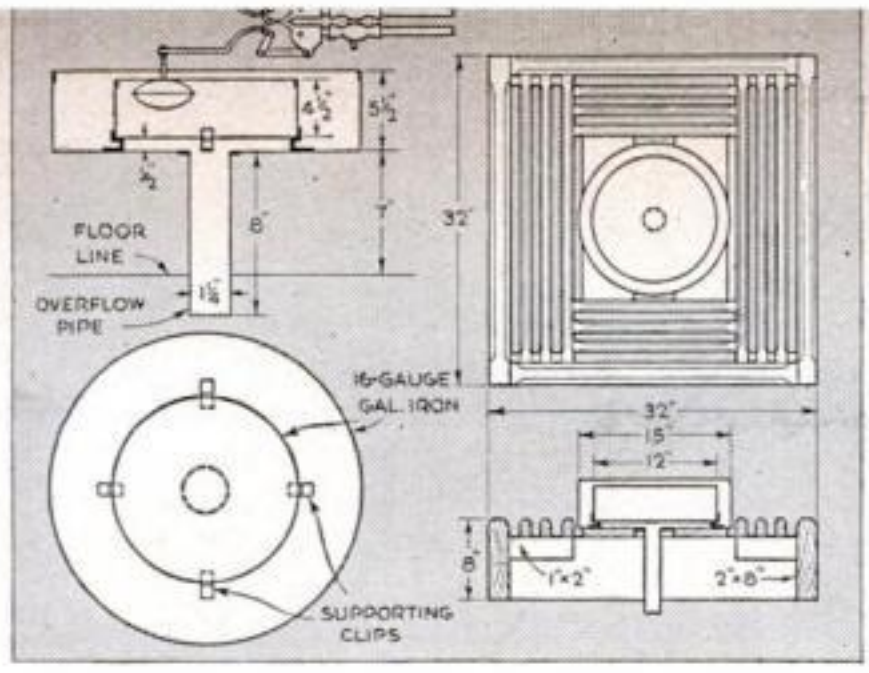
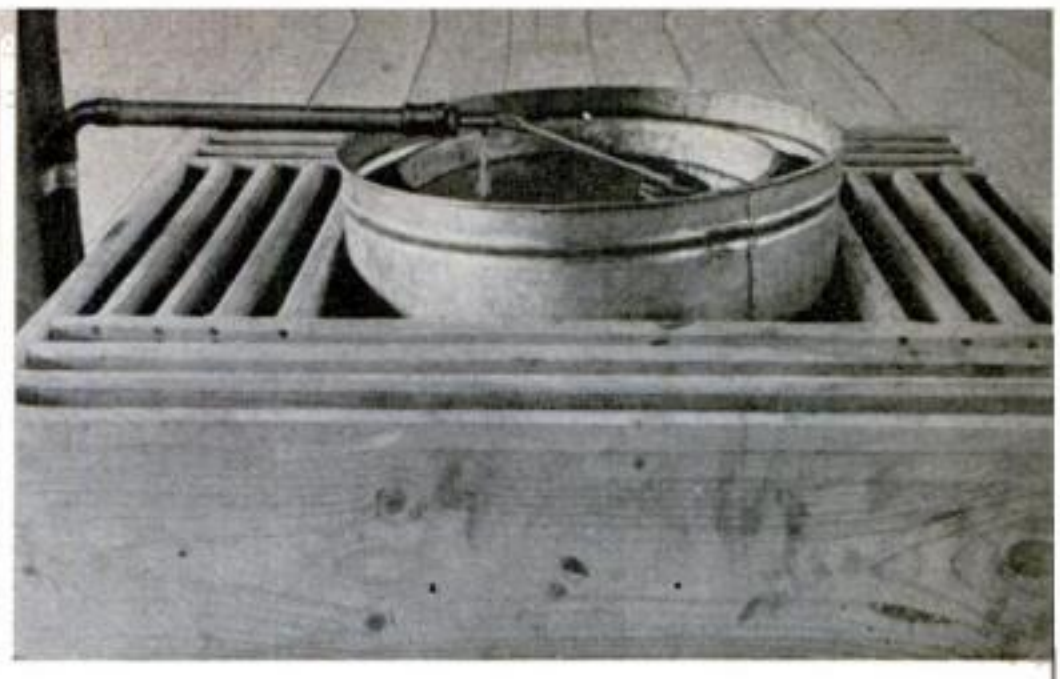




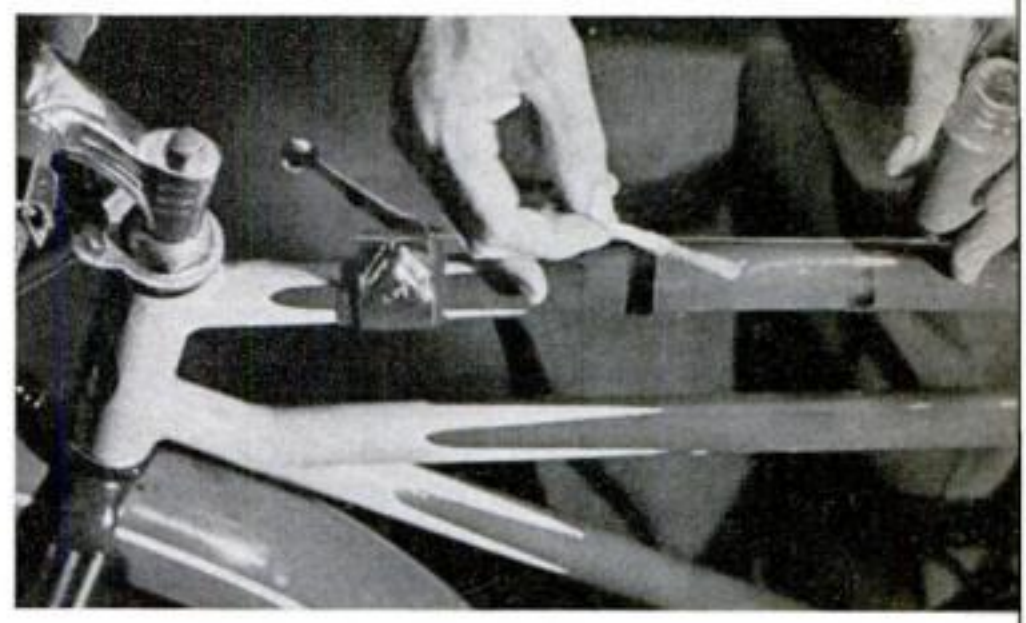
Poultry Watering Stand Built with Slatted Wooden Top

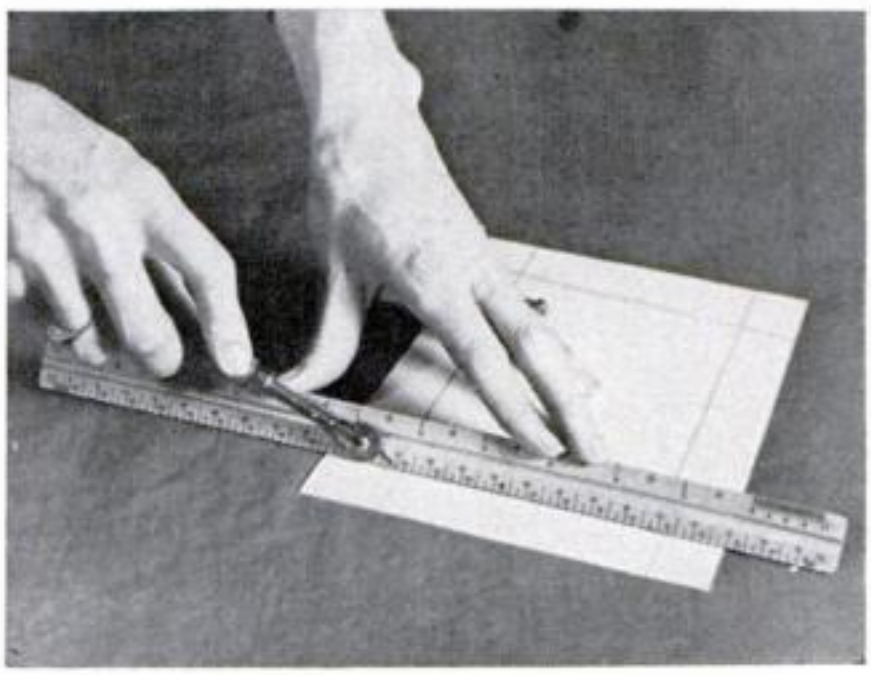
BECAUSE wood must replace metal and wire wherever possible on the farm, the poultry and agricultural engineering departments of the Massachusetts State College, at Amherst, have devised a watering stand that dispenses with the usual wire top. It is replaced by a slatted top similar to the floors extensively used in English poultry houses. The stand is sanitary, cheap, and easy to build, and can readily be lifted for cleaning.

Much water can be saved by using a valve float, as shown. However, if the float is not available, the automatic feature can be dispensed with by letting water drip constantly.—RAYMOND T. PARKHURST.

Model-Airplane Dope Conceals Scratches on Bicycle Frame

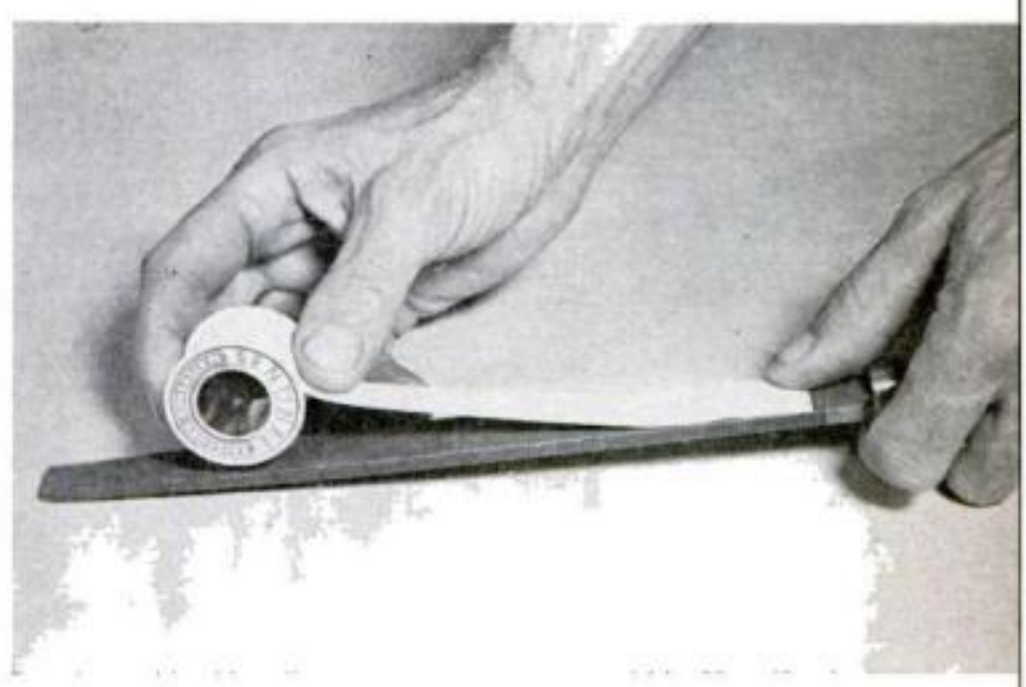
IF YOU leave scratches on your bicycle, the metal is likely to rust. However, scratches can easily be touched up by wrapping cellulose or adhesive tape around the frame about ½" beyond each end of the damaged area and applying model-airplane dope of the right color. Sand the surface lightly; then apply the color with a small brush or a twisted pipe cleaner. After removing the tape, polish with floor wax.—R. K.





Dressmaker's Tracing Wheel Scores Cardboard Neatly

A DRESSMAKER'S tracing wheel is handy for scoring cardboard without breaking it, when making up small gift or mailing boxes. Simply mark the cardboard, then run the tracing wheel on the lines.—B. J. B.



Tape Applied to Side of File Prevents Damage to Work

IN USING an ordinary file where it would mar the work if more than one face does the cutting, it is a good idea to cover the side of the file that is not to cut with adhesive tape, as above.—B. N.

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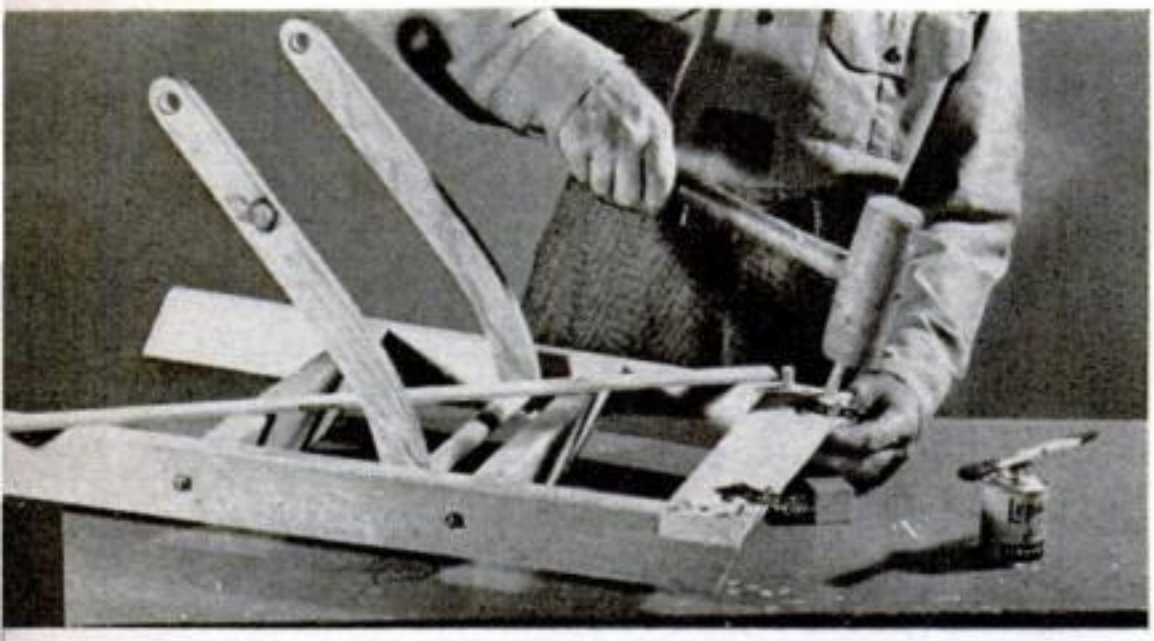
Folding Ladder Stool

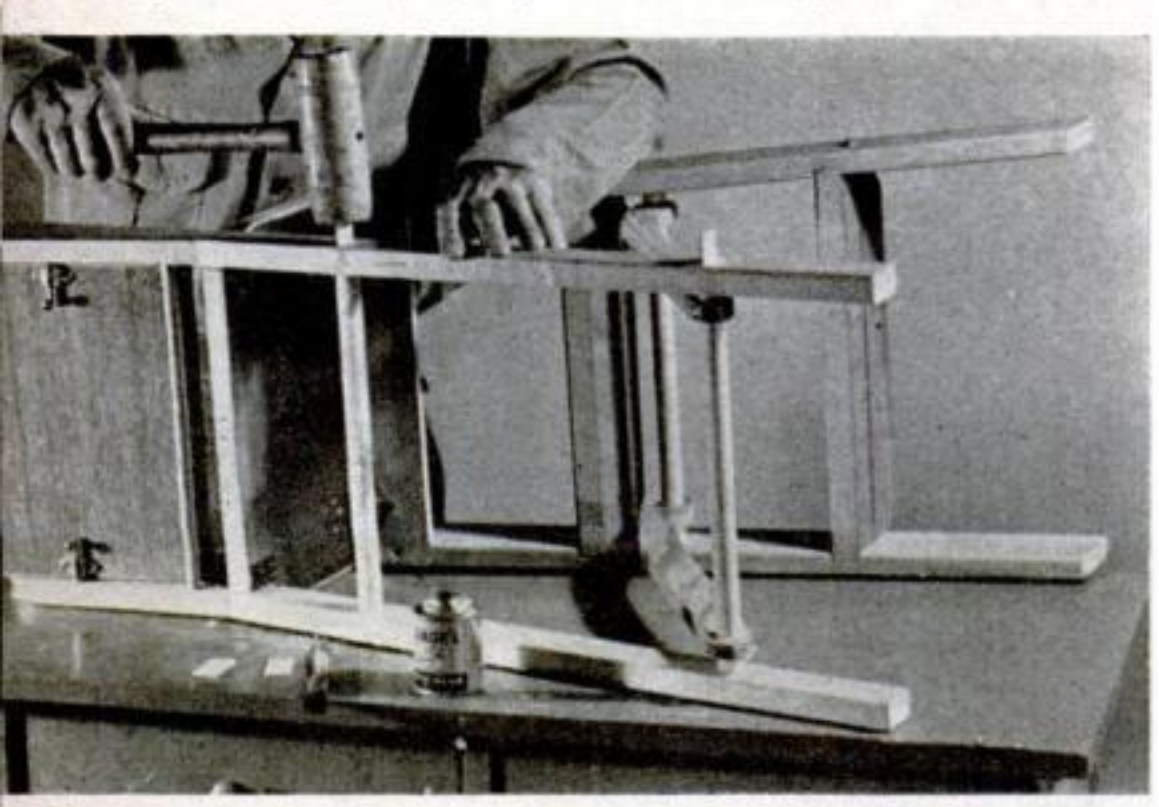
THIS sturdy folding stepladder stool has several features that are not found in any other stool of its type. Built for long life and designed so that it will remain free from wobble, it should find favor with housewives in performing their usual tasks about the home. Locked in the horizontal position, the back rest will hold a pan of water for cleaning windows and the like. Plenty of foot room is provided on the seat if it is necessary to stand on it for extra height. The stool is so well balanced that there is no danger of its tipping over when the user steps off. When the stool is folded, its depth is only 6¾", which permits it to be stored conveniently in a closet.

The drawings show the different parts and their dimensions. Maple or birch is the most satisfactory wood to use, except where otherwise specified on the plans.

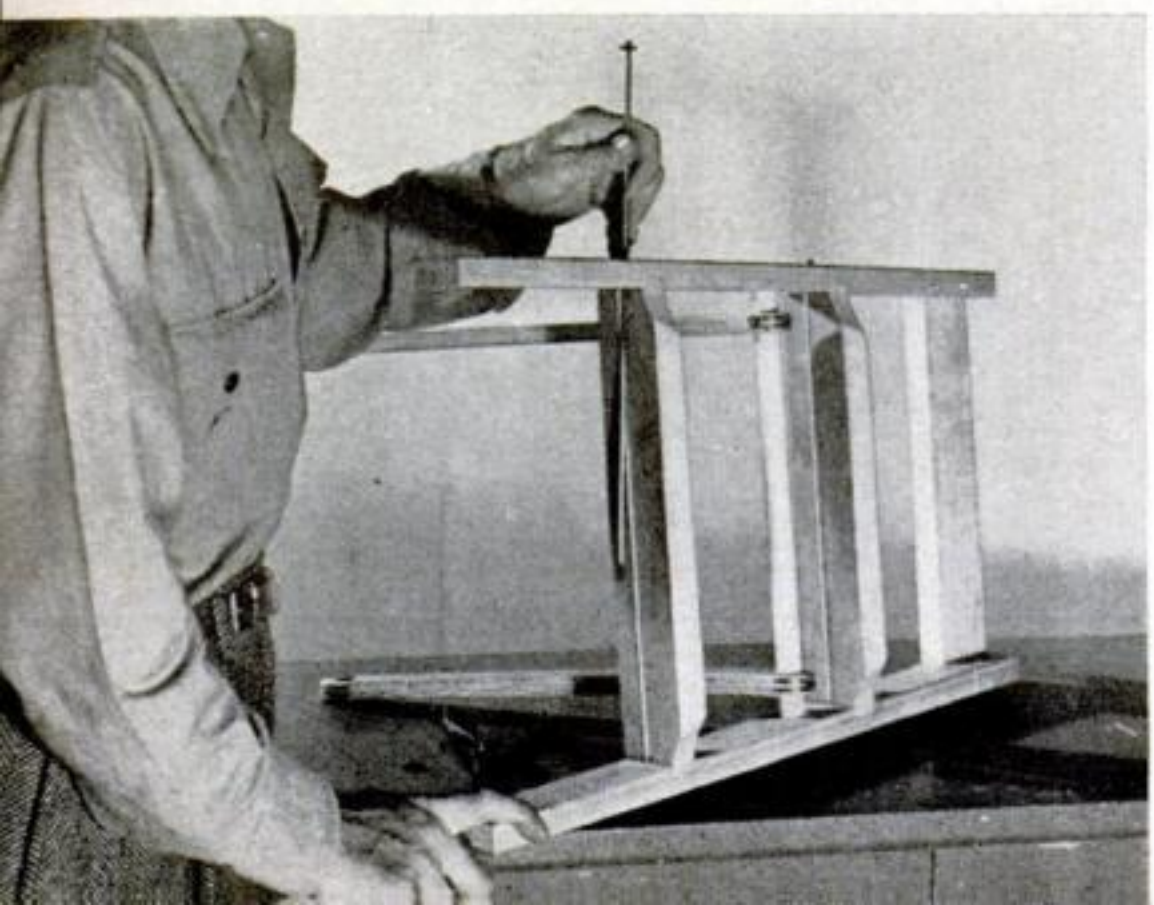
It is best to assemble the stool temporarily so that minor adjustments may be made. This is especially important in respect to the joint where the arm connects with the front legs. To locate this properly, fold the stool and then open and close it until the correct pivot point is found—one that gives a spread of 15" from the front to the rear legs. The connecting arms are fastened solidly to the ¾" dowel rod about 1" in from the front inside faces of the legs.

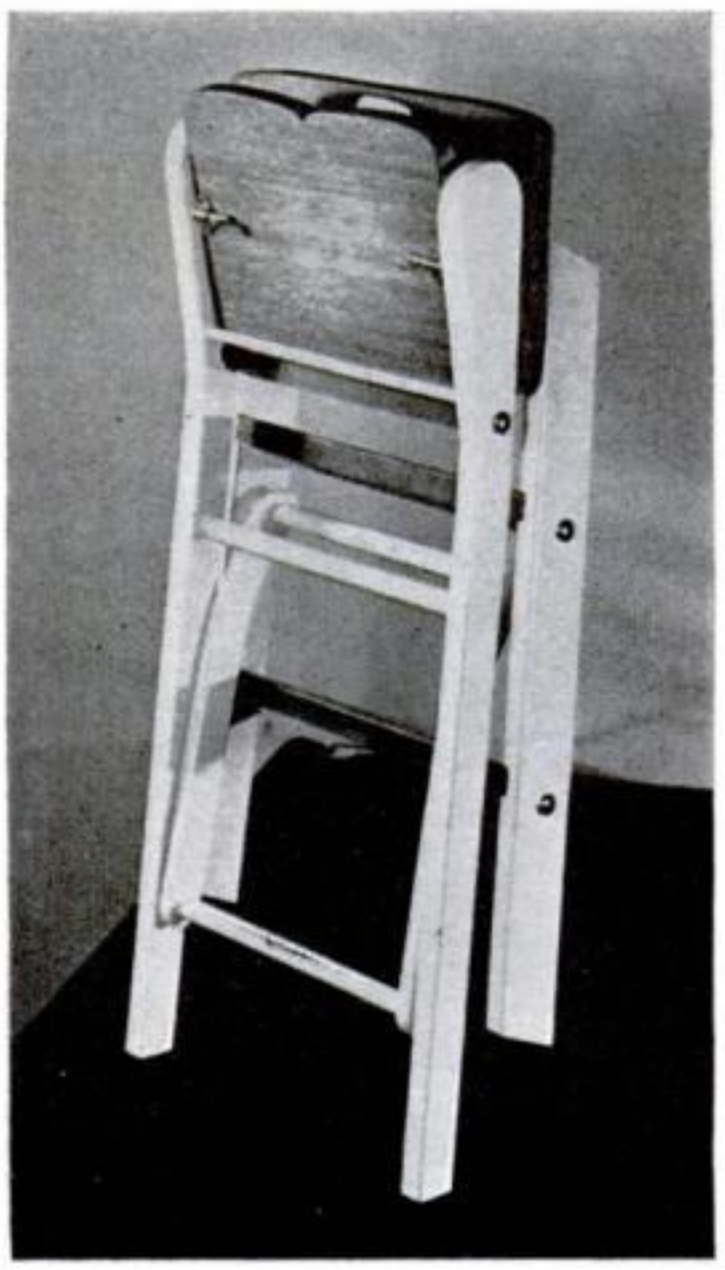


Above, dowels are inserted after the rail is fastened to the legs and sloped properly. Notice that upper dowel is slanted



Wedges being driven at right angle to the grain in the rear legs. Below, inserting brace rods beneath each foot rest





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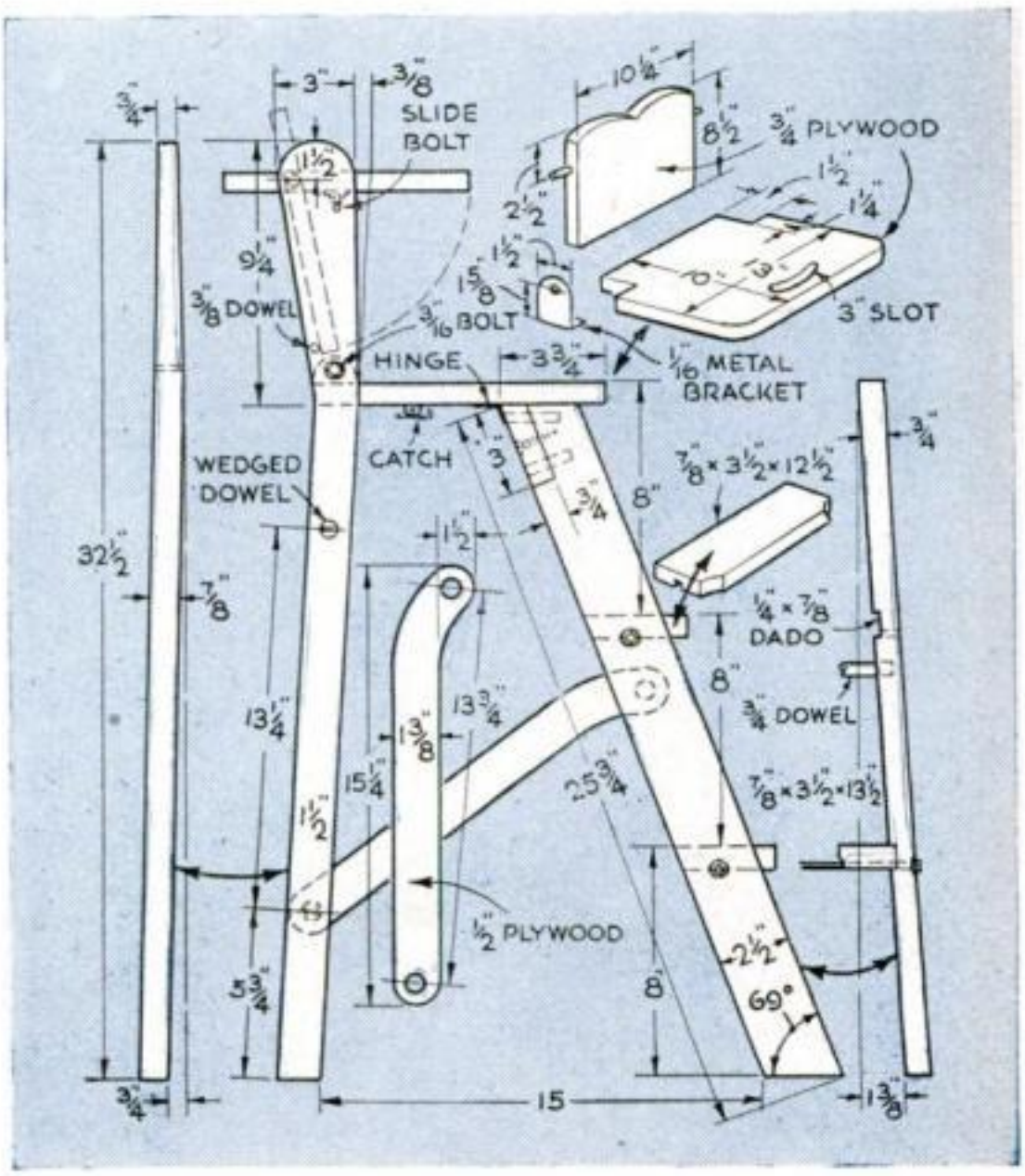
By FRANK HEGEMEYER

The proper angle for the cuts on the front legs, including the dadoes, is obtained by tilting the saw table to 86 deg. and the miter gauge to 69 deg. Each step has a 3/16″ groove on the underneath side for the 3/16″ brace rod. It is a good idea to place small washers between the seat brackets and the rear legs to prevent marring the paint.

When all adjustments are satisfactory, knock down the piece and reassemble. The leg-connecting arms should move freely on the lower dowel of the rear legs. Note particularly in the drawing the slope of the front and rear legs.

After all edges have been rounded and the whole thoroughly sandpapered, stain the steps, seat, and back rest a walnut color. The remainder of the piece can be painted any color preferred. The exposed nuts are covered with caster glides to avoid damage to expensive hosiery.

A cupboard catch is fastened to the seat, as shown, and the strike attached to the front leg rail. Grasping the seat by the slot and lifting the stool automatically causes it to close and lock by means of the catch. Although the back rest can be put to innumerable uses to lighten many home tasks, it should be understood it is not to be used under any circumstances to stand on.



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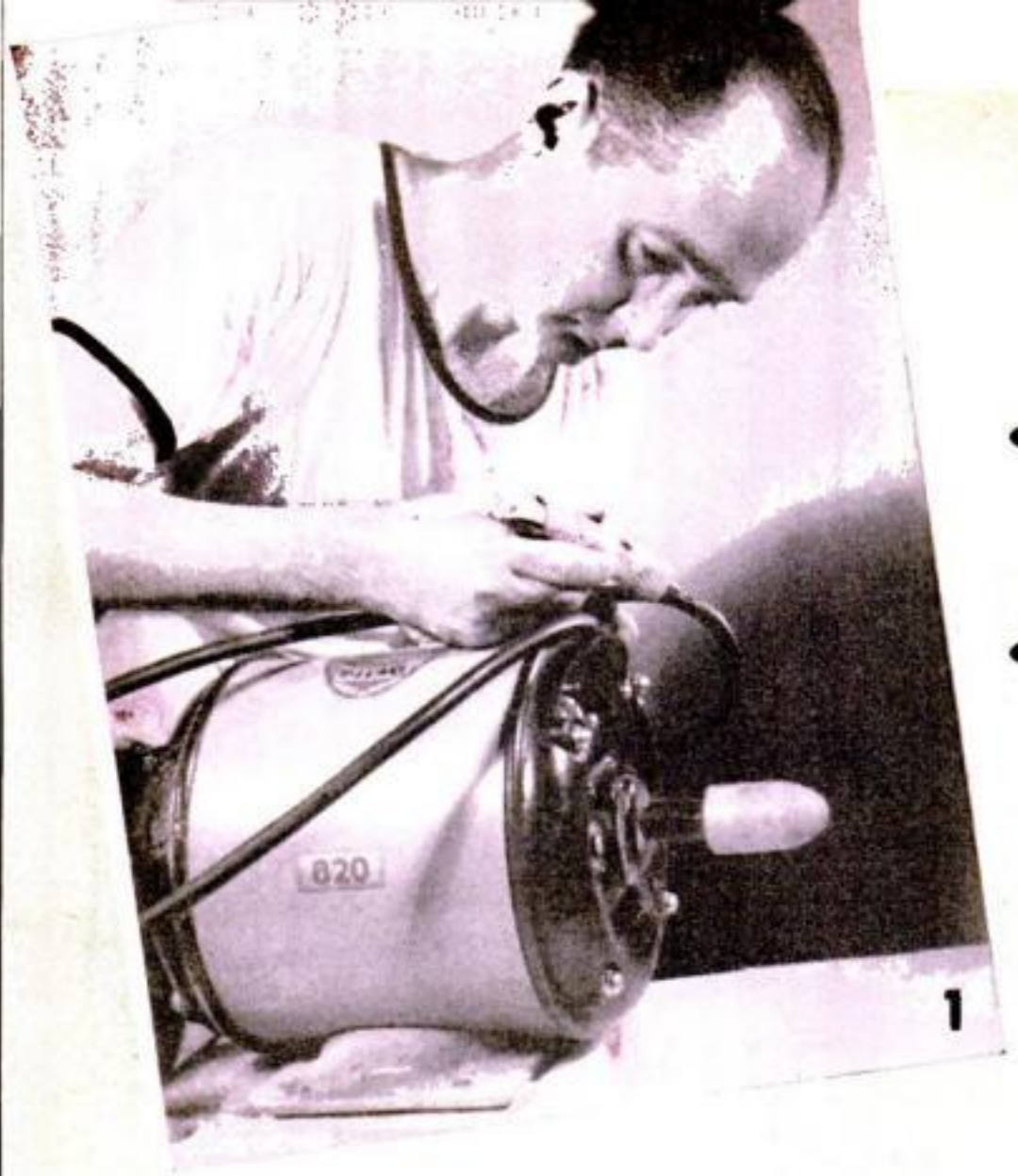

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MAKING *Lamp Cords Last Longer*

By GEORGE S. GREENE

YOU can no longer buy new lamp cord freely, and as it becomes more scarce it will be more and more difficult to operate electrical appliances. Lamp cord is really indispensable. The one certain way of making the cords you already have last for the duration is to take care of them.

Once the insulation is broken or worn through, it should be repaired immediately in order to save the entire cord, which in the larger sizes is difficult to splice. In Fig. 1 is shown the heavy attachment cord of an electric sander. It had come into contact with the fast-rotating motor shaft so that the insulation was worn deeply. Several applications of tire-cut filler were made, completely filling the depression and giving a permanent repair. Another flexible and durable material suitable for this purpose is ordinary automobile-top sealer.

When a cord is attached to a plug, a narrow strip of friction tape may be wrapped around the insulation near the end, as in Fig. 2, so as to wedge the wire in the plug and relieve strain in case the cord is used to pull the plug from a socket.

Prevent fraying and breaking of fine wires by twisting them and then soldering (Fig. 3). Bend the end of each wire into a hook, to serve as a connecting lug.

One frequent cause of frayed wires is broken socket bushings (Fig. 4). These cost only a cent each and they protect the cord from wearing against the metal socket nipple. If the bushings are not at hand, wrap several thicknesses of tape around the cord where it enters the nipple.

Attention to these small but important details will aid in keeping your lamp cords in perfect condition.

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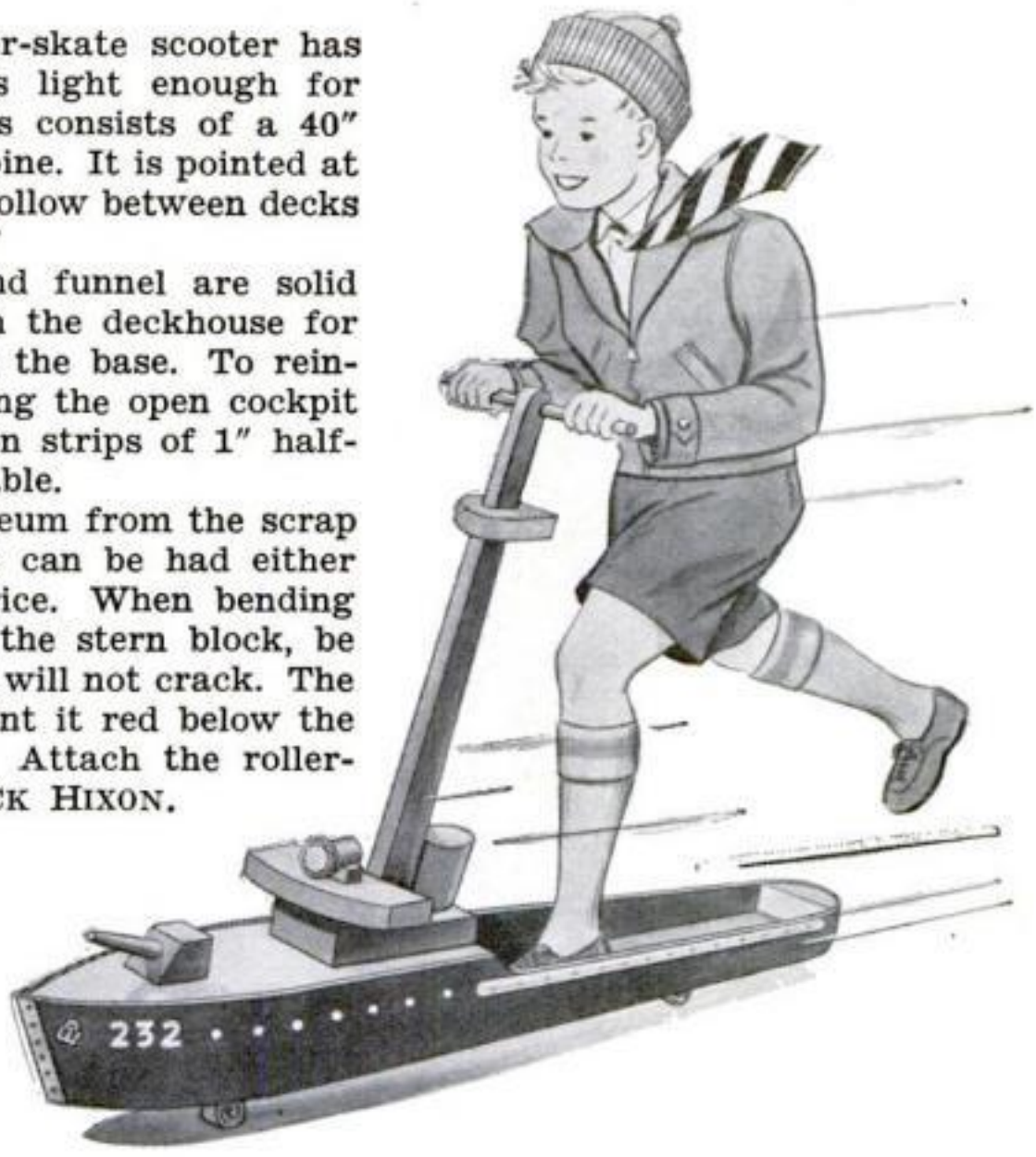
TOY SIDEWALK CRUISER

BROUGHT up-to-date, this roller-skate scooter has convincing naval lines and is light enough for speedy "cruising." The chassis consists of a 40" length of 1⅛" by 4" stock such as pine. It is pointed at the bow, rounded at the stern, and hollow between decks forward, with linoleum "planking."

Deck structures, gun mount, and funnel are solid white-pine blocks. A hole is cut in the deckhouse for the mast, which is screwed fast to the base. To reinforce the edges of the linoleum along the open cockpit in which the skipper stands, nail on strips of 1" half-round molding—hardwood if available.

Narrow strips of high-grade linoleum from the scrap piles of retail floor-covering stores can be had either for the asking or at a nominal price. When bending linoleum around a curve, such as the stern block, be sure the material is warm so that it will not crack. The smooth side should be outside. Paint it red below the water line, battleship gray above. Attach the roller-skate parts in the usual way.—DICK HIXON.



It's anchors aweigh and full speed ahead for the boy who boards this nautical sidewalk scooter. You can make it from shop scraps. Be sure it's ready in time for Christmas!

TOP VIEW

SEAM BINDING

SECTION

2"SQUARES

¾" STOCK

1"×3⅛"×4"

232

HW 459

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KNIGHTS AND MEN OF Camelot

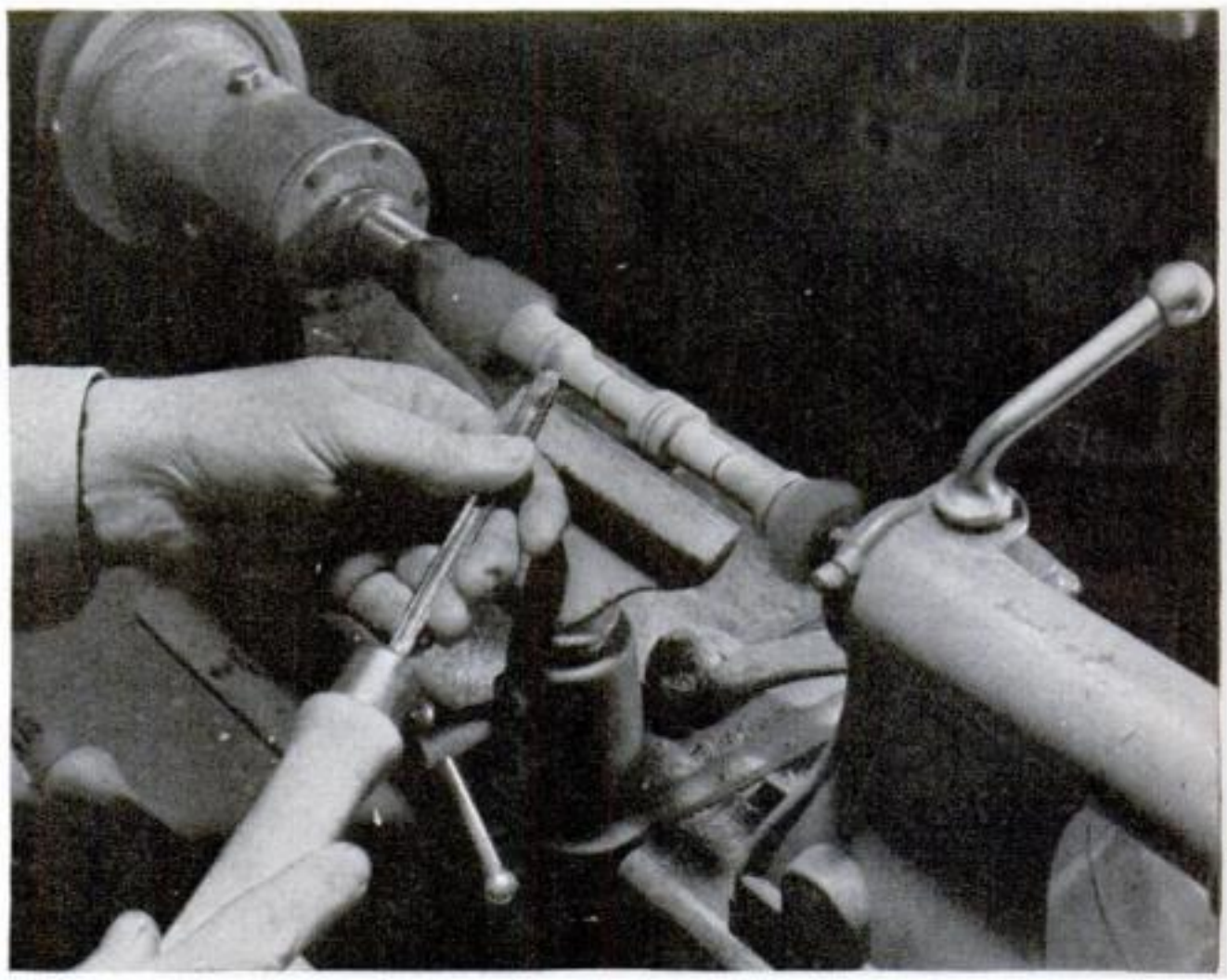
MODERN GAME PIECES DESIGNED BY JUAN OLIVER

CAMELOT, the popular modern game invented by George S. Parker, suggests in its play no less than in its name the tournaments and wars of medieval times. Two opposing forces, each consisting of ten men and four knights, face each other in the middle of the field between their "castles"—the two starred squares at each end of the board. Each player's object is to occupy the castle of his opponent. By means of three simple basic moves the miniature armies make brilliant attacks, swift retreats, flanking movements, and lightning charges through the opposing ranks.

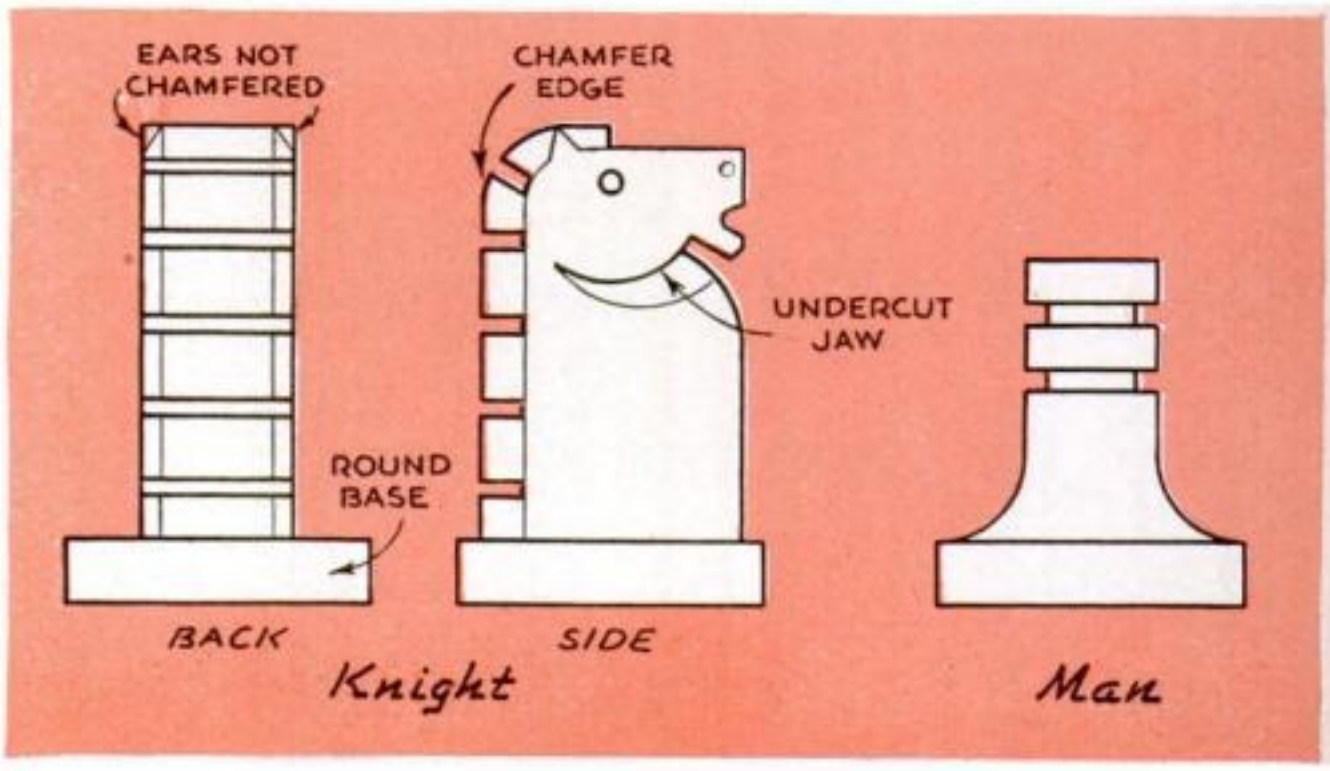
The game of Camelot is patented by Parker Brothers, Inc., and cannot be reproduced without permission. By special arrangement, however, POPULAR SCIENCE is enabled to present an original design for new, modern Camelot pieces that home craftsmen who want something different from the standard ones sold with the board may make for their own enjoyment or as gifts. Mahogany was used for the pieces shown, but any hardwood suitable for turning will serve. A striking set can be made of colored plastic, if the material is available.

The plain men can be turned four at a time from 6" lengths of stock mounted between lathe centers, as shown in the photograph. Face the bases off true or slightly concave so that the pieces will stand firmly.

Slices of 7/8" dowel will do for the bases of the knights. Jigsaw the bodies from 1/2" stock. Drill a hole through for the eyes and spot a shallow hole on each side for the nostrils. Undercut each side 1/32" deep for about 1/8" under the jaw line. Bevel the



Turning the men of Camelot is a simple lathe operation. Set up this way, four pieces can be turned at one time. The game requires 20 men



Knights—of which eight are needed, four for each side—are jigsawed from 1/2" stock, then undercut at the jaw, and beveled at the mane. Bases are sliced from a 7/8" dowel

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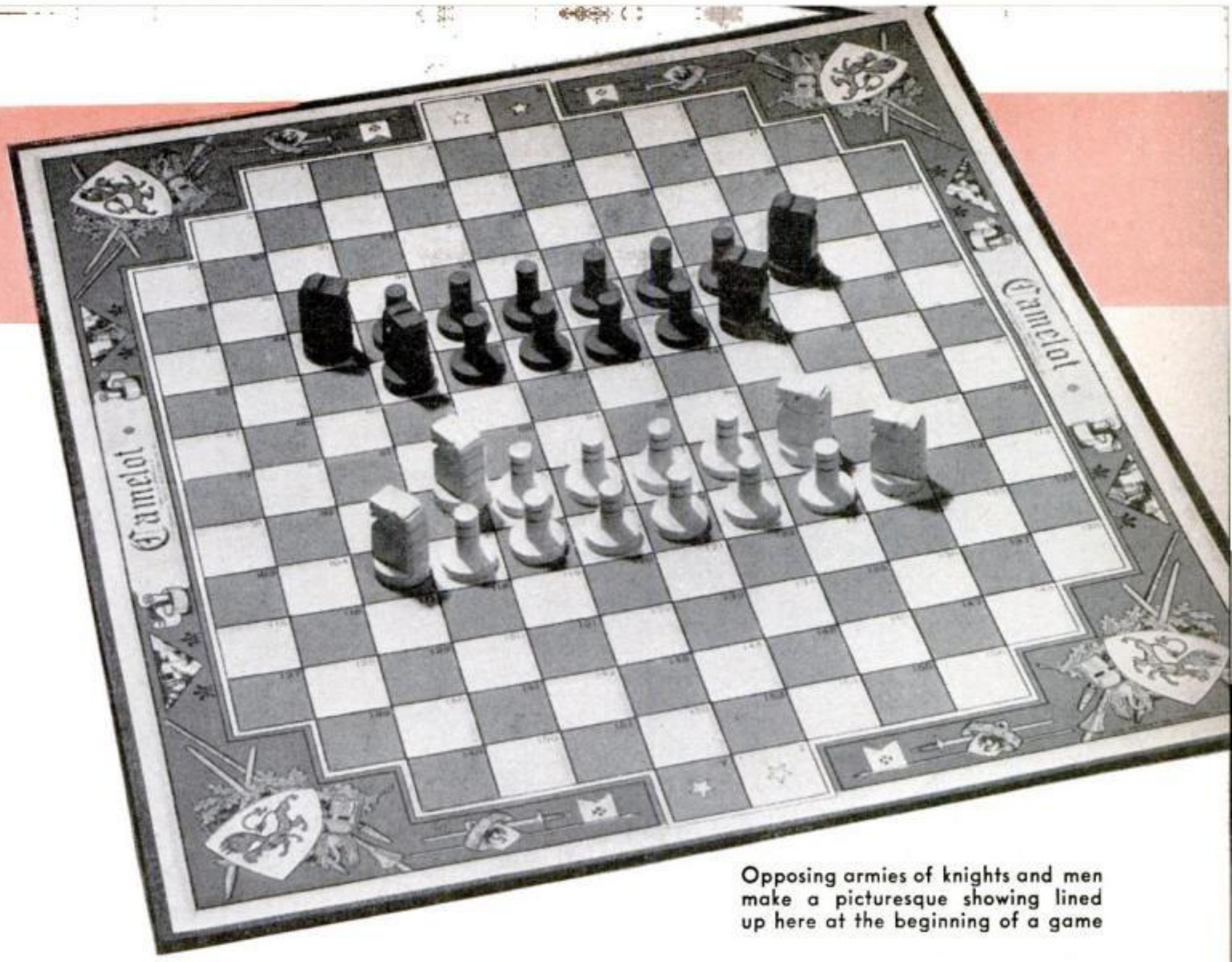

Opposing armies of knights and men make a picturesque showing lined up here at the beginning of a game

two back edges 3/32", but leave the tiny ears untouched so that they stand out against the mane. Dowel or simply glue the body and base of each knight together.

Sand the pieces smooth, apply two coats of thinned varnish, and finish the two sets in contrasting colors—with enamel if a glossy effect is wanted, or with japan colors for a flat finish. If a light wood is used, one set might be left natural and the other stained dark. Or two woods might be used —one light, the other dark.

ANTIQUING PLASTER CASTS [*PAINTING*]

Plaster of Paris casts should be left to dry for several weeks before being antiqued. Then give the surface a coat of white shellac. Let this dry and apply a second coat of shellac.

Obtain a tube of artist's burnt-umber oil paint and thin with turpentine until it flows readiy. Paint the surface of the cast with this thin color. With a soft cloth immediately wipe off all the surplus paint from the high lights or raised and smooth portions of the cast. Some of the color will remain in the depressions and undercuts. Let this stay to give a natural antique effect. When the paint is dry, polish the surface gently with the soft cloth.

POPULAR SCIENCE MONTHLY SHOP DATA

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Club members dismantle old uprights, donate the metal for scrap, and use the wood in craftwork

Old Pianos Yield War Metals and Rare Woods

OLD upright pianos, no longer good for batting out martial airs, are going to drop out of the skies in quantity on Berlin and Tokio if a program developed by the Hoosier Home Workshop Club in Indianapolis, Ind., spreads to the rest of the country. Members of this workshop group have dismantled more than 100 of these relics so far, salvaging enough metal from each to make two and a half 500-pound bombs. Just one of these bombs, in the right place, will sink an enemy cruiser.

There are thousands of these old uprights in the homes of America, kept only for sentiment or because no one knows exactly what to do with a worn-out piano. The rub comes in salvaging the metal quickly because of the difficulty of transporting the pianos and of stripping them of their wood.

Peter J. Van Geyt, program chairman of the Hoosier Home Workshop Club, solved this problem in a unique way. It should interest other clubs affiliated with the National Homeworkshop Guild, as well as the manual-training or shopwork departments of public and private schools, or any organization looking for a substantial way to aid the war scrap drive and, incidentally, to obtain for their own craftwork projects a valuable supply of seasoned woods. The rosewood, for instance, in some of these old pianos can hardly be duplicated, and the mahogany and walnut are of fine quality.

In Indianapolis, a leading piano company collects and distributes turned-in pianos to depots set up in club members' garages in convenient parts of the city. The company likes the idea so much that it even offers the owners of the old boxes full trade-in allowance on new spinets and grands.

Club members are organized in squads, and spend from one to three evenings a week in dismantling the old uprights. The metal is sold to scrap dealers, the proceeds being turned over to the U. S. O., and the wood—allotted to the club members in return for their time—is devoted to such projects as toy making for Christmas charities. There is so much wood, in fact, that members have a surplus to take home.

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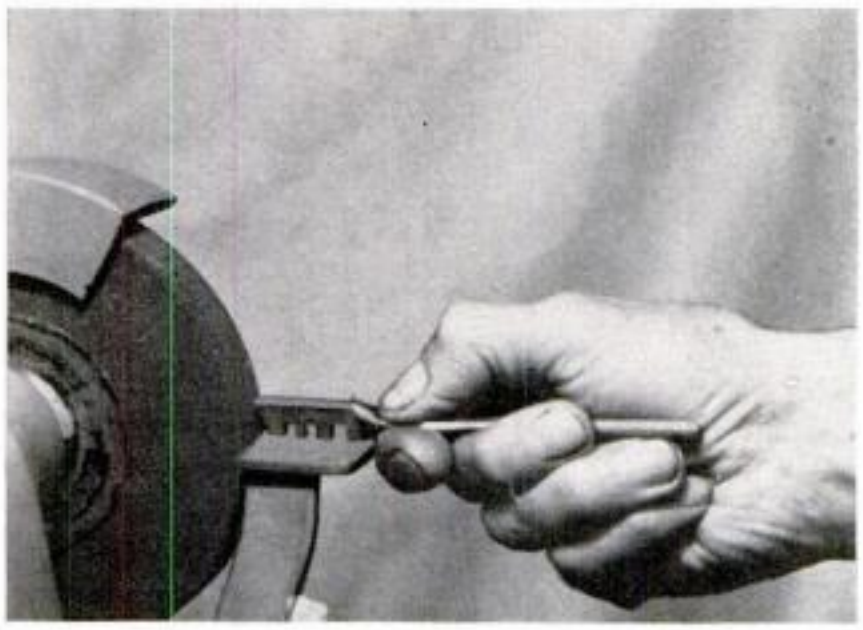
Old Glass Cutter Redresses Small Grinding Wheels

DIAMOND dressing tools, used for truing grinding wheels, leave the surface so smooth that for certain types of work it cuts too slowly and causes overheating. This difficulty can be overcome by using a mechanical dresser or star wheel—a tool consisting of a number of notched disks—to break away or open up the surface. However, star wheels are too coarse and heavy for use on small wheels.

In our shop we get excellent results by redressing wheels 1½" to 5" in diameter with worn-out glass cutters as shown below. These cutters are of the type having a small steel wheel that turns on a hardened pin. Since they are just as effective after they have become too dull for cutting glass, we use only old ones, of which we usually get a good-sized handful from a glazier for the asking.—W. C. CHENEY.



Homemade Leather Toe Clips Make Bicycling Easier

BICYCLE racers and other cyclists who take long bike trips know the advantages of having toe clips or rests on their pedals. The trouble is that most of the toe clips on the market are designed to fit on metal pedals, while the ordinary bike is equipped with large rubber-surfaced pedals.

Toe clips for such pedals can be made from two schoolbook leather straps and a few small split rivets. The straps can be attached to the pedals as shown in the photographs above. Make them of appropriate length according to the required size of the toe web, so that the foot will be held snugly.—RAY KERSHNER.

PLATING WITH VARIOUS METALS [*ELECTRICAL*]

Although less familiar than the customary plating metals, tin, iron, lead, cobalt, antimony, and arsenic are sometimes useful in special applications, such as for decorative work.

Tin. This forms an excellent protective surface, particularly for iron and steel. A suitable electrolyte consists of 6 oz. tin chloride, 6 oz. ammonium oxalate, 1 oz. oxalic acid, 1 oz. dextrine and 1 gal. water.

Iron. Worn iron parts are sometimes plated in order to build up the surfaces to avoid replacement. Use 24 oz. ferr*ous* sulphate, 12 oz. ferr*ous* chloride, 20 oz. ammonium sulphate, and 1 oz. finely powdered charcoal, all dissolved in 1 gal. water. The charcoal is included because it helps prevent brittleness of the deposit.

Lead. This should not be plated on work that will come into contact with food. Use 6 oz. caustic soda dissolved in 1 qt. water; add 1 oz. lead oxide, and when it is completely dissolved add ¼ oz. gum arabic and enough water to make 1 gal. Use at a temperature of about 150 deg. F.

Cobalt. Like lead, this metal should not be used on articles which are to come into contact with food. A fast-working electrolyte consists of 4½ lbs. cobalt sulphate, 5 oz. boric acid, 2 oz. sodium chloride, and 1 gal. water.

Antimony. This is a hard and brittle metal with a lustrous gray appearance. Add 18 oz. potassium carbonate and 12 oz. pulverized antimony sulphide to 1 gal. water; then boil for an hour. Add enough water to replace that lost by evaporation, and filter. A temperature of 150 deg. F., at 3 volts, is recommended.

Arsenic. Lacking the pure metal for use as anode, deposition can be carried out with carbon anodes and a solution of ½ lb. white arsenic dissolved in 1 gal. hydrochloric acid. The solution as well as the metal are, of course, POISONOUS. It will be necessary to add more arsenic as the metal plates out.

POPULAR SCIENCE MONTHLY SHOP DATA

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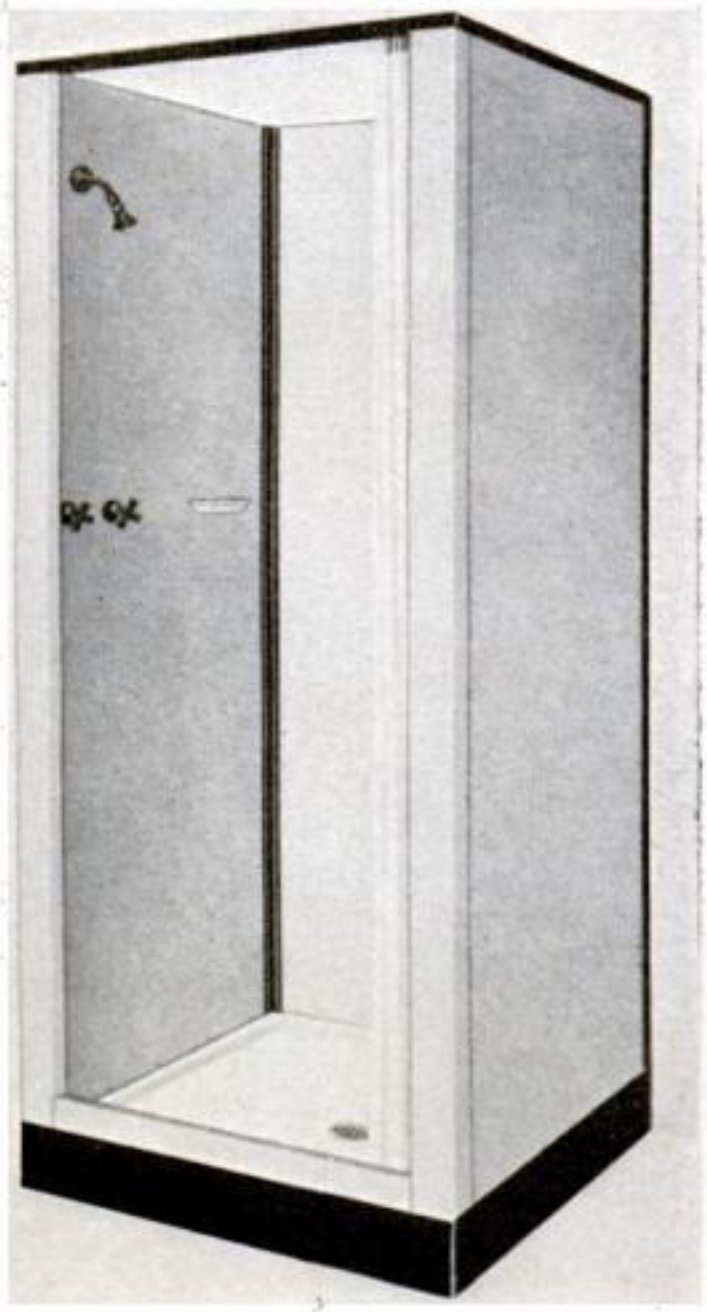
IDEAS for HOME OWNERS

HEAT-REFLECTING RADIATOR SHIELDS, usually made of aluminum, are now available in efficient composition substitutes. Foil reflectors come in rolls of four sheets, enough for two average-sized radiators, at a cost of only a dollar a roll. The sheets are placed behind the radiator and preferably extend a little above. They are fastened to the window frame or a strip of molding on the wall. These fuel-saving shields are especially valuable in drafty or hard-to-heat rooms, since they reflect the radiant heat rays usually absorbed by cold walls back into the room.

PREFABRICATED CABINET SHOWERS now on the market dispense almost entirely with critical metals. The model illustrated below is made of precast concrete and waterproofed fiber board, and comes fully equipped.



GALVANIZED ROOFING NAILS are conserved by a new "spot-welding" method (not illustrated) for the application of asphalt shingles, roll roofing, and the so-called "split-sheet" and built-up roofings. It was developed on the West Coast to meet the shortage of roofing nails. In the case of an ordinary three-tab asphalt shingle, two nails instead of four are used to fasten it in place, and each tab is then "welded" down with a spot of plastic asbestos-asphalt compound.

BLACKOUT

HOLD-DOWN BRACKETS now on the market will prevent escape of light around the edges of ordinary window shades. They come complete with washers and nails and are fastened on the sill in such a position that they catch the folded-over hem of the shade when it is brought down a little farther than usual.

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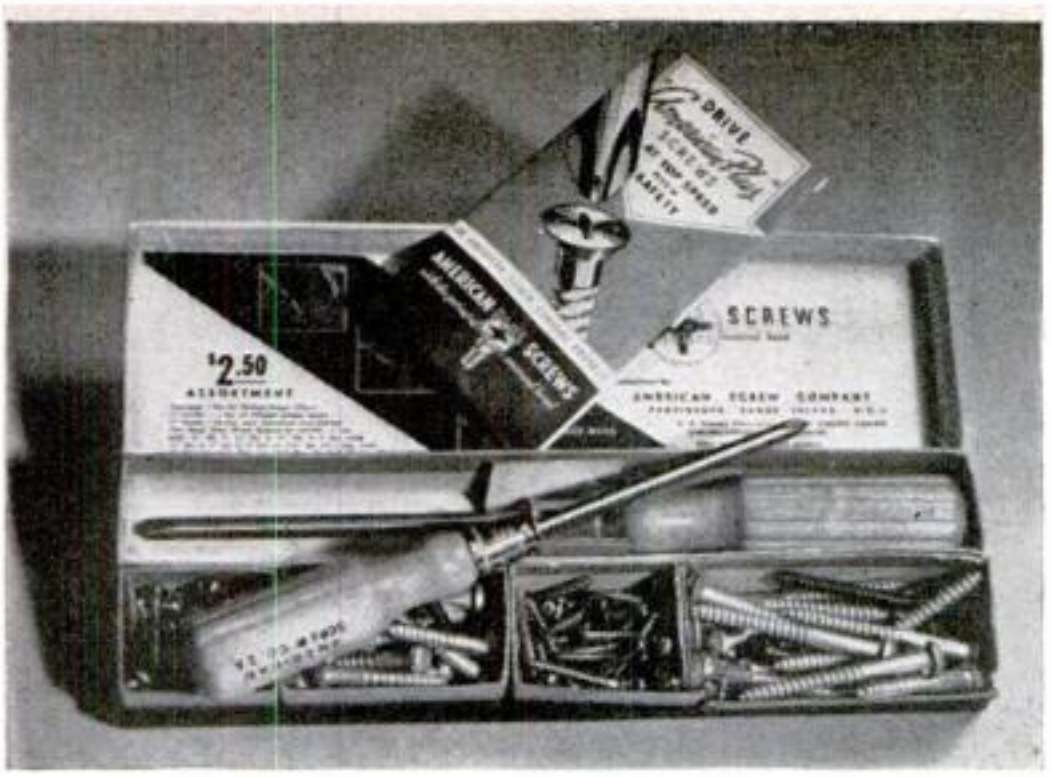
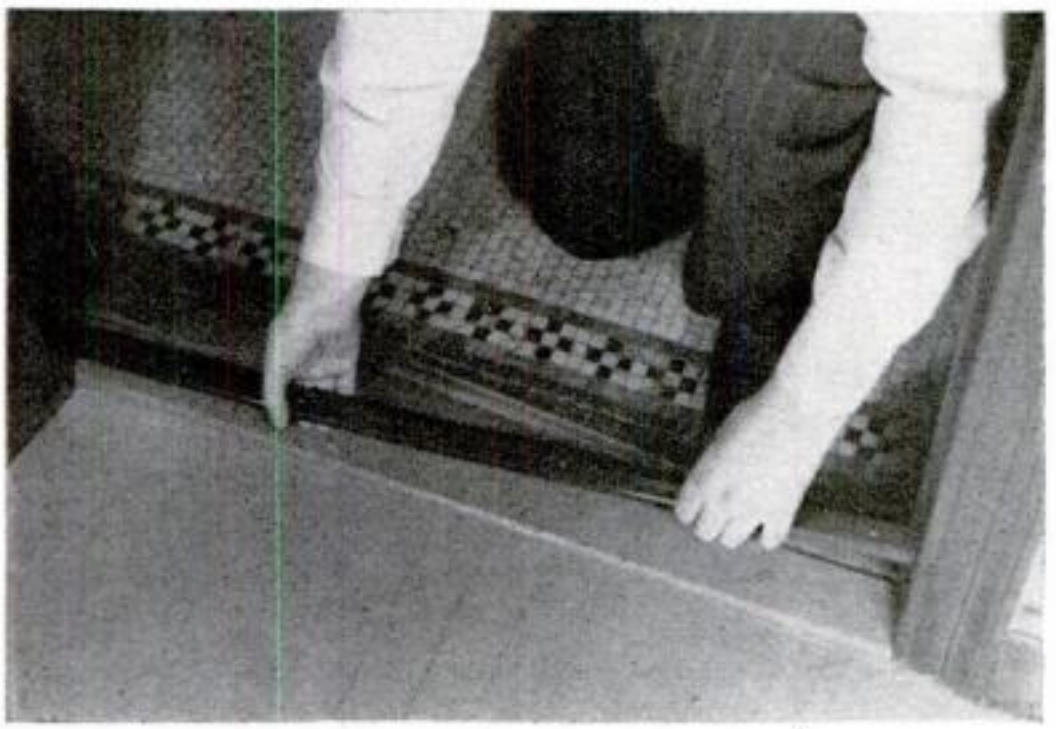


UTILITY KITS containing an assortment of screws with the recessed-head design, and special drivers to fit them, are now being sold in hardware stores. This new type of screw, in addition to being more decorative, eliminates the burring that mars slotted heads, prevents slipping, sets up tighter, and is self-centering, requiring the use of only one hand to start and drive. Two driver sizes fit 85 percent of all recessed-head screws commonly used, while four drivers will fit the entire range of screw sizes. Power bits are also being manufactured now to fit all sizes of these screws.



A WEATHERSTRIP THRESHOLD made of unbreakable plastic, highly efficient as a fuel saver, can now be obtained in any length desired, complete with interlocking hook, nails, and screws. Its deep brown color blends with typical flooring materials and finishes, and under conditions of ordinary traffic its plastic composition is practically indestructible. The strips, extruded in 1⅛" and 1⅜" widths, are installed with countersunk screws and can be applied in a relatively short time with common household tools—saw, hammer, and screw driver.

ACCESSORIES FOR THE HOME

THIS NEW BULB, one of many varieties developed for blackout use, operates on only two watts and can be kept lit during a blackout even with unshaded windows. Dispensing with the filament wire used in bulbs of standard construction, it resembles the fluorescent type of lighting. The bulb has an inside coating of fluorescent powder and is available in a wide range of colors — blue, green, red, yellow.

THE BLACKOUT SHADE shown at right is now available at low cost in many department and chain stores. It is made of heavy midnight-blue crepe fiber and is as easily installed as an ordinary window shade. In addition to being lightproof, the shade is impervious to fire unless water-soaked.

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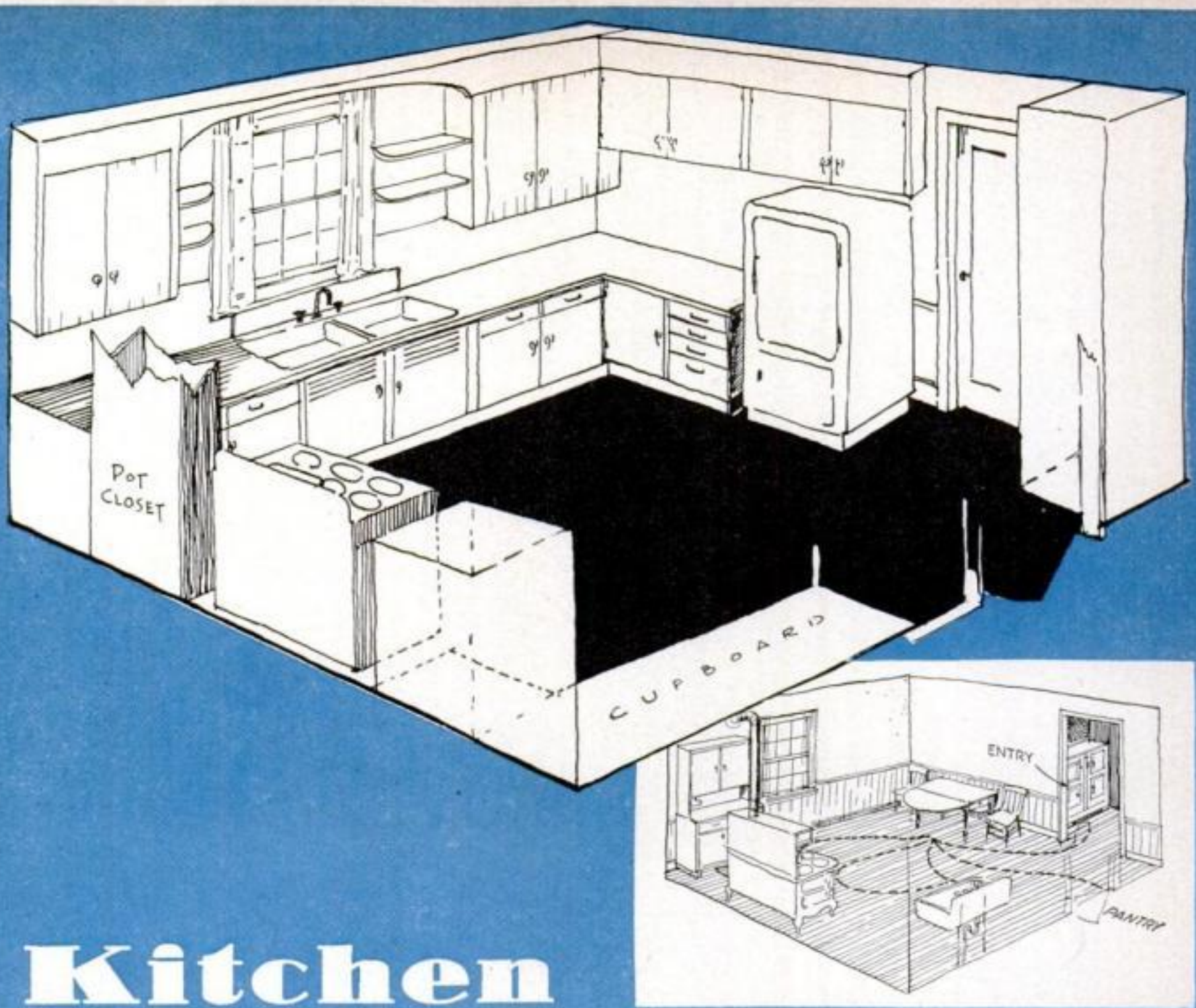

Kitchen Modernization under wartime conditions

By JOSEPH ARONSON

Interior Designer

KITCHEN modernization is an old story, but war conditions have put a new obstacle in the way—and this provides an opportunity for the amateur woodworker to help himself. We cannot now go out and buy steel cabinets; even good wooden ones are comparatively hard to get. Linoleum tops with stainless-steel trim, chromium fittings, and metal accessories are all forgotten for the duration.

The kitchen sketched was entirely remodeled with homemade cabinets of plywood. First, a more efficient plan was evolved, reducing by half the motion required for usual kitchen duties. The only major alterations consisted of moving the sink and changing the height of the window sill from the floor. The refrigerator was brought in from the back hallway, the stove was replaced with a more compact modern one, and the remainder of the space was filled with cabinets, closets, and cupboards, considerably in excess of ordinary demands. The adjoining pantry became only a serving passage and a breakfast bar.

The cupboards at each side of the sink hold cooking utensils, while the drawers are planned for kitchen knives and similar flatware. Inside the doors that form the sink enclosure are all the sink-cleaning articles. The cupboards over the sink, flanking the window, hold all the dishes. Between the long cupboard and the range is a pot closet, 24″ wide, 15″ deep, and extending to the ceiling. All the pots, saucepans, and similar

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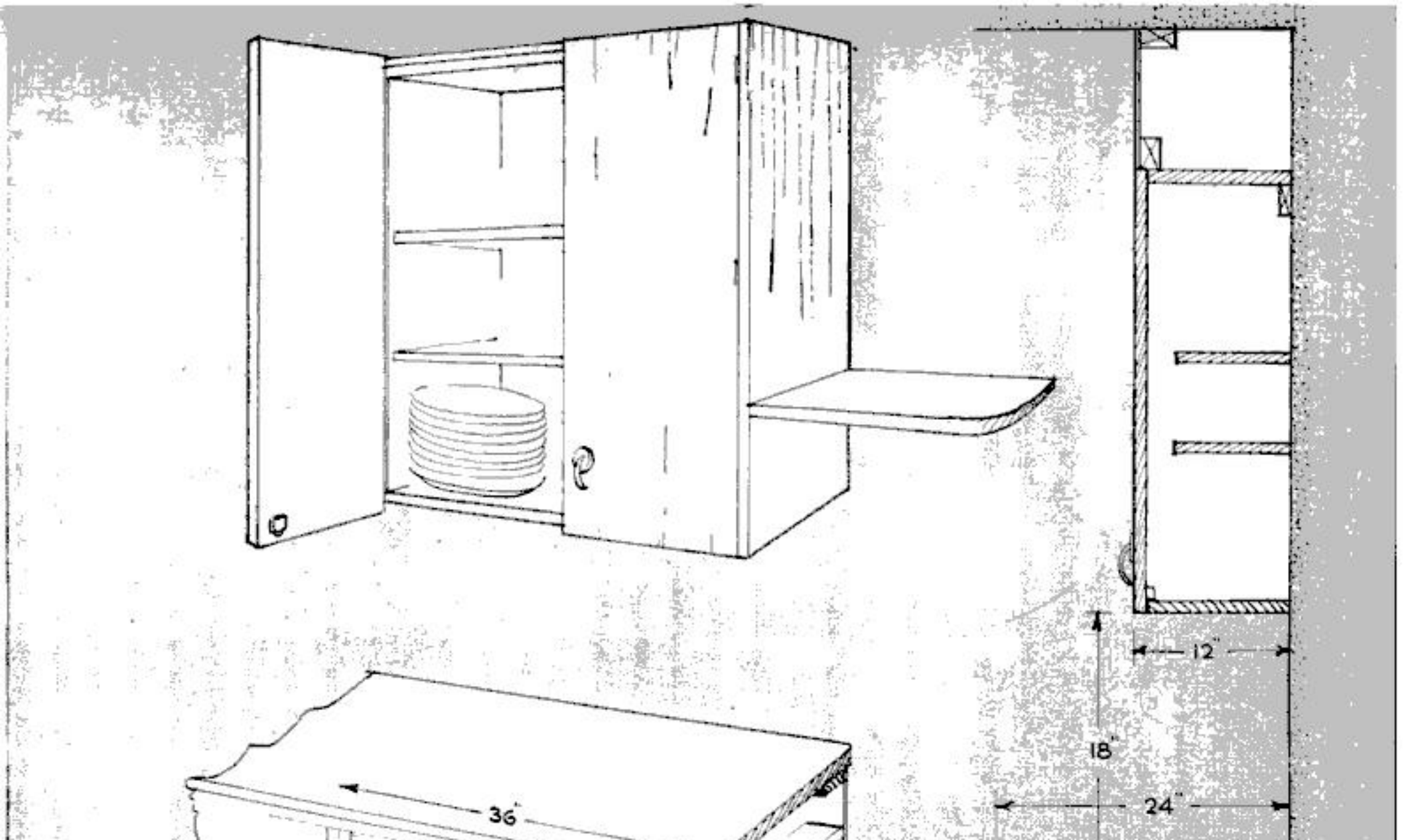

utensils are hung visibly on the back wall of this closet; pot covers are arranged on the door. To the left of the range is a low cabinet that provides additional working surface. On the adjoining wall is a provision closet. On the opposite wall the work surface is carried over another cabinet up to the refrigerator. The re-entrant angle or inside corner has been fitted with an ingenious pivoting compartment. Over this section is a very shallow cupboard for glassware. In the corner between the two doors is a closet for cleaning equipment.

The cabinets around the sink were made as separate units and then fitted into place. They all have solid hard-maple tops, the separate boards being joined with waterproof glue. The wood is very carefully and thoroughly sanded and left raw. With reasonable care this maple becomes bone white in time; the surface is most agreeable to work upon. The top is screwed to the cabinet from underneath.

The cabinets are simply constructed by doweling or nailing the upright partitions to the floor and to a front and back top rail, ¾" by 3". Frames for the drawers are made of the same stock. The doors are ¾" pine (or fir) plywood. Backs of ¼" fir plywood are used throughout, as this makes the cabinet more verminproof. The base is an inset strip 4" high, set 2" in to provide toe room.

The intermediate shelf is made about 4" shallower than the space. A sort of gallery or pocket is attached to the door at about this height. This provides storage for the many smaller articles that have a tendency to get lost on larger shelves.

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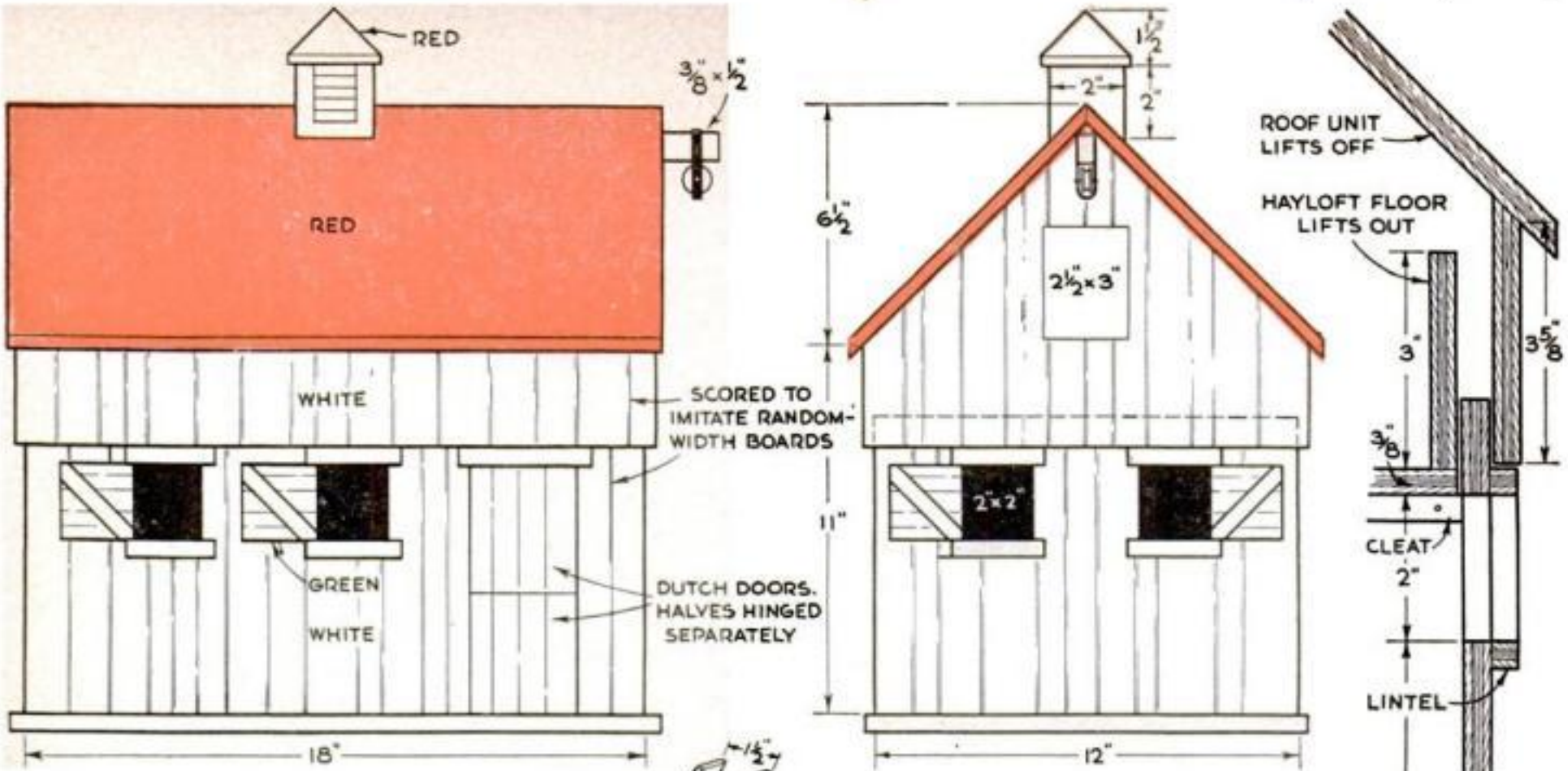

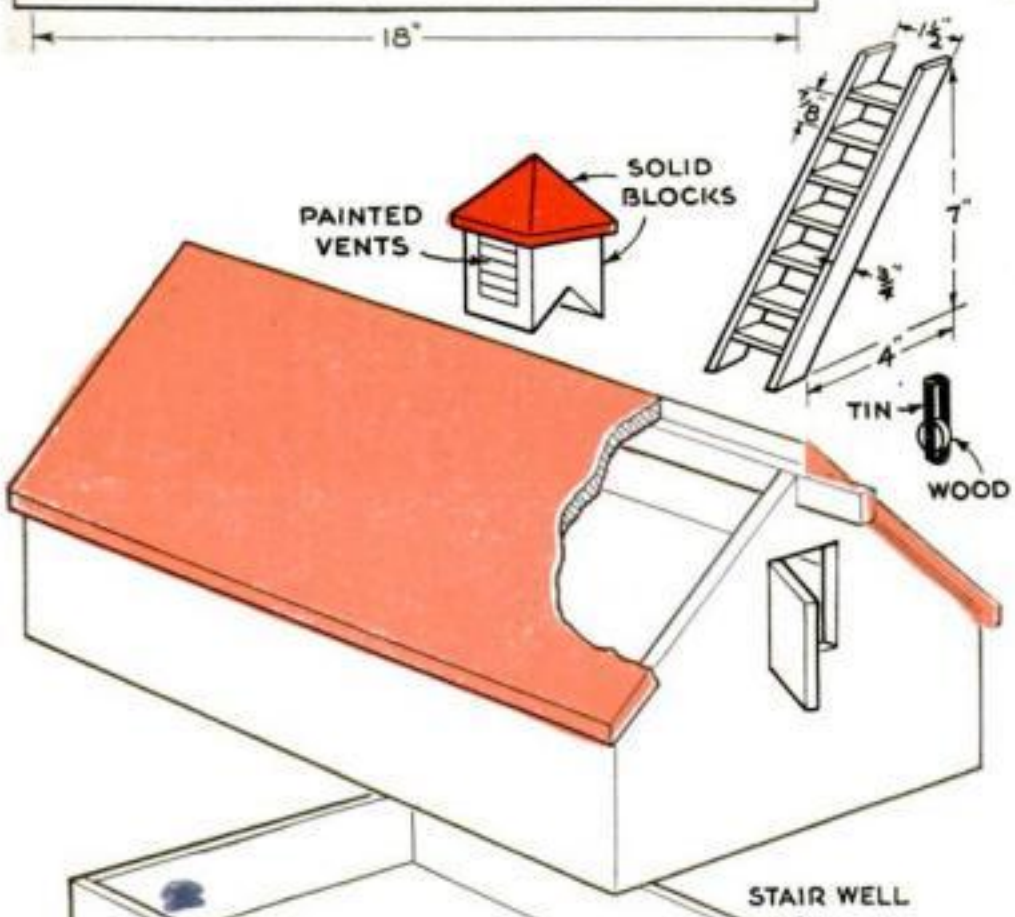

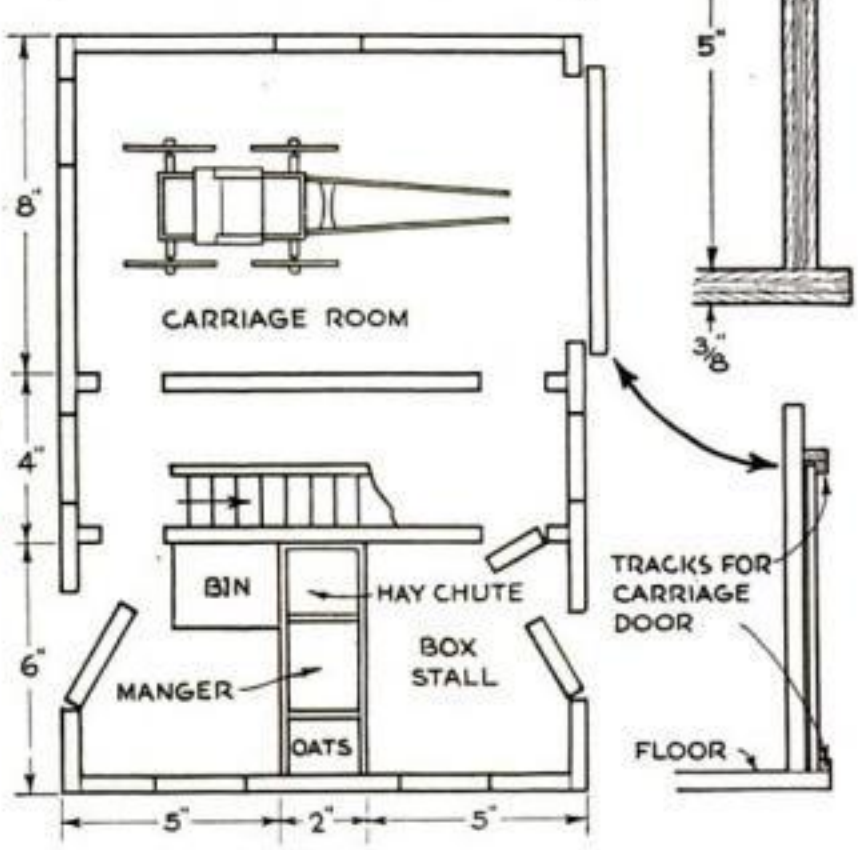

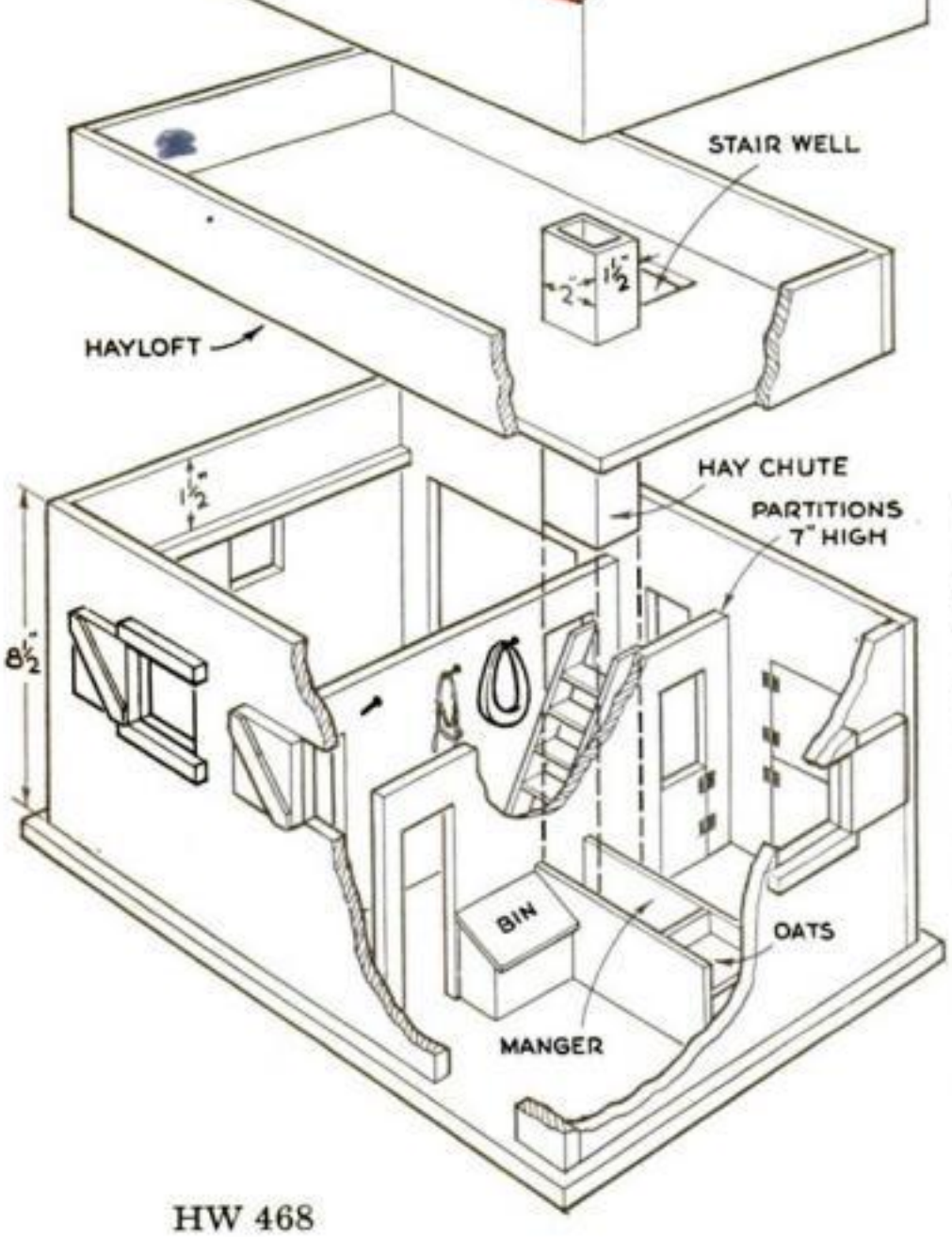

HW 468

Toy Barn

By HI SIBLEY

REMEMBER the one-horse barn common in the days when Dobbin provided the family transportation? This toy barn may well awaken old memories in many of us—and what child won't enjoy hitching and unhitching the horse, filling the hayloft, locking up for the night, and so forth?

For the convenience of the young owner, the roof lifts off to give access to the hayloft, which in turn can be removed to expose the stall and carriage room. Any material ¼" to ½" thick is suitable for the building, ⅜" plywood being ideal. Windows are cut out and have no sash; sills, lintels and shutters are secured with brads and glue.

Note that the walls of the roof unit rest

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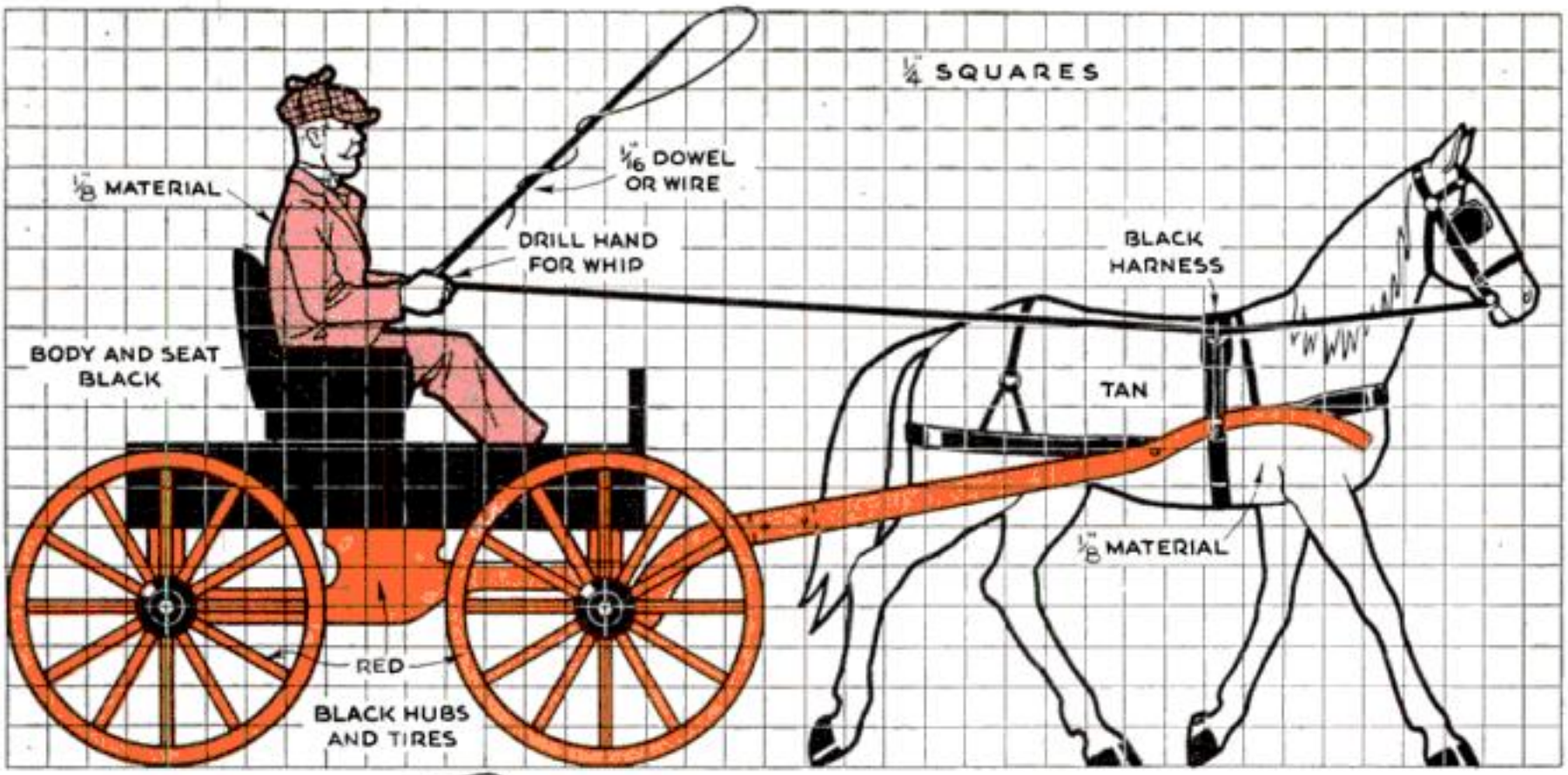

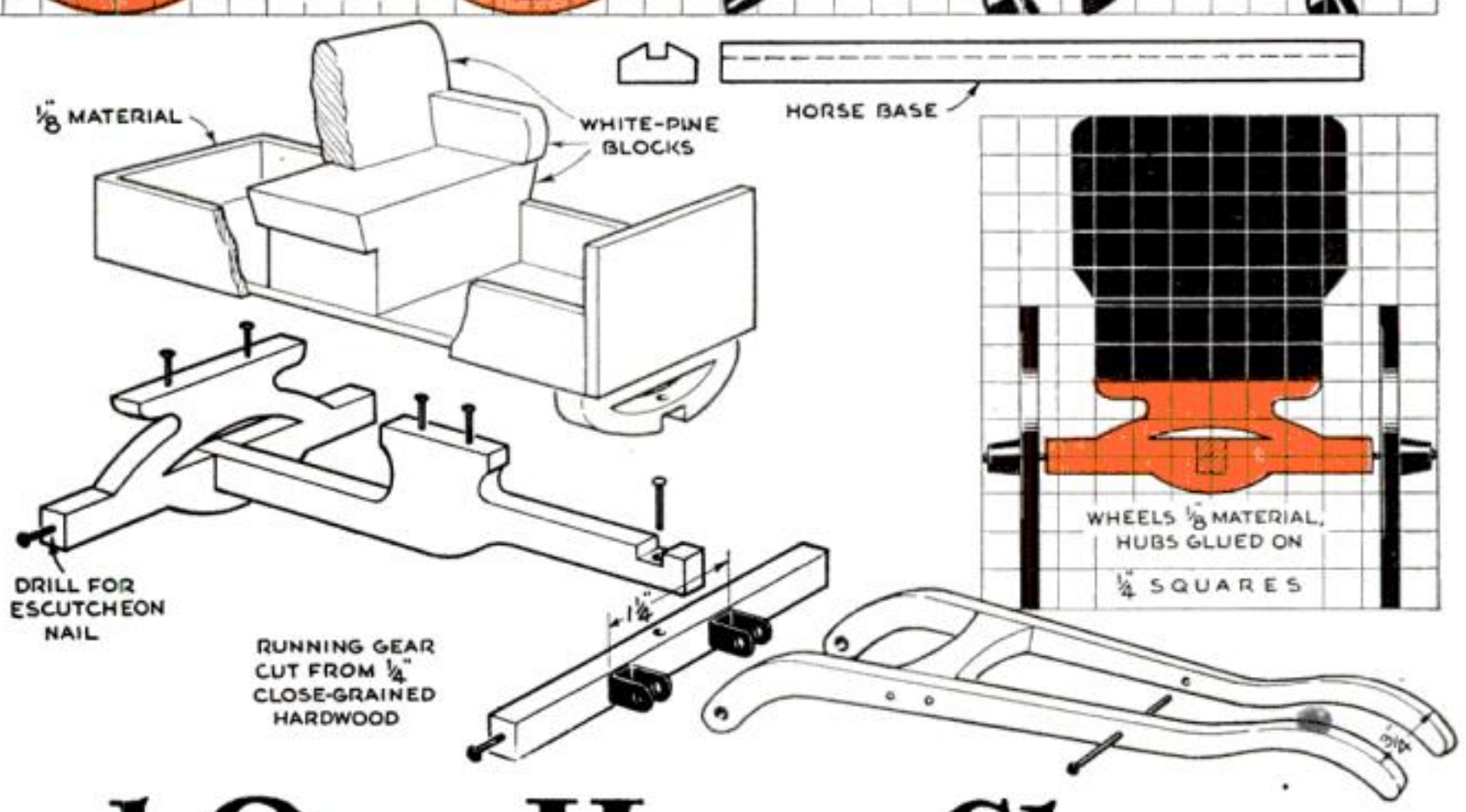

and One-Horse Shay

on the lintels, and the hayloft is supported by the partitions as well as by cleats on the end walls. The hay chute is fixed in the loft floor, and should be just long enough to come to the top of the manger. Hinge the lid of the feed bin.

Escutcheon pins driven into one inside wall serve as harness pegs upon which to hang the tiny halter, collar, bridle, belly-band, breast strap, and so forth. These can be made of black oilcloth, or the harness may simply be painted on the horse.

The carriage room is large enough to enable one to hitch up the horse inside in stormy weather, the animal being led from his stall through the half-door between. There is also an outside Dutch door for the box stall, to permit taking the horse to pasture. Make a large sliding door, set in rabbeted guides, for the carriage room.

The carriage is constructed entirely of wood, the wheels being jigsawed from ⅛" material. Cut the spokes and rims as thin as you can for the sake of appearance. Hardwood is recommended for the "springs" and running gear. Holes should be drilled for the escutcheon-pin axles.

Cut the horse from ⅛" stock and set it in a base. The driver may be cut from the same material and doweled to the seat.

Sun-dried lawn clippings make fine hay, which can be pitched down the chute into the manger. Fill the feed bin with birdseed "oats." Provide a wooden pail for water.

HW 469

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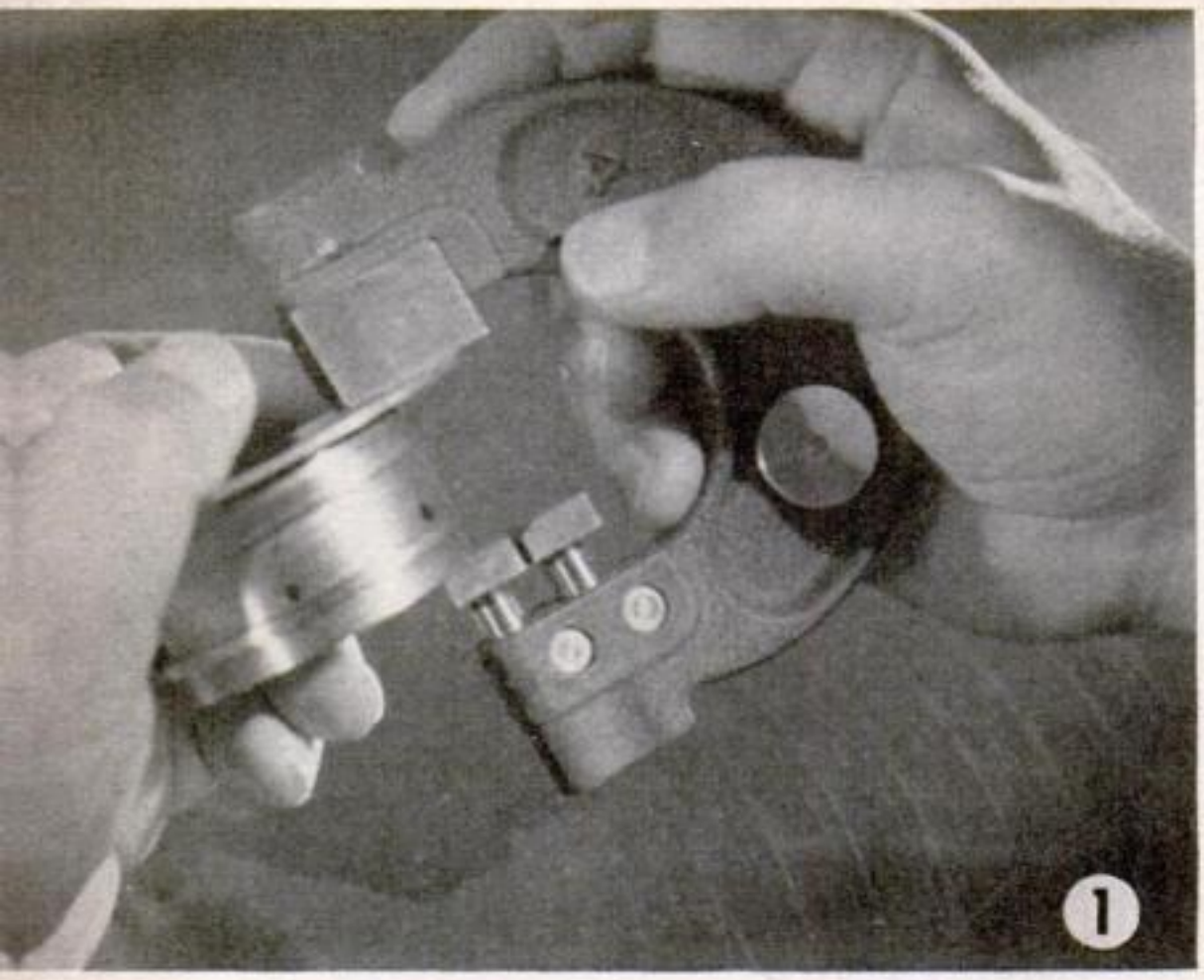
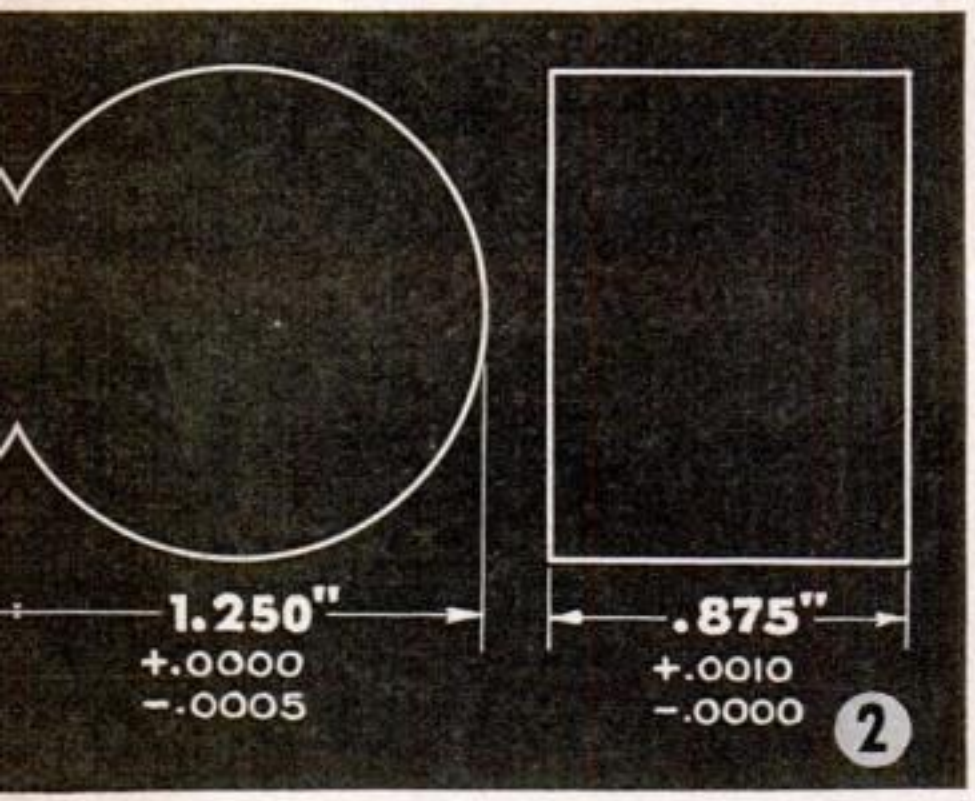
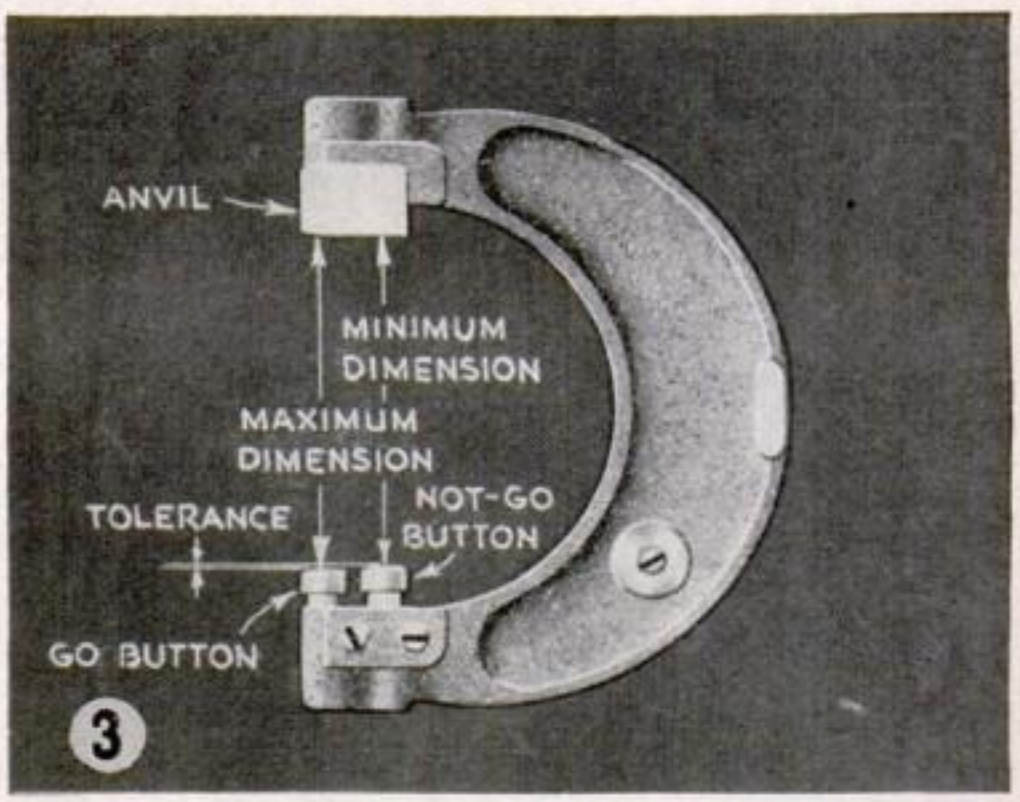
What You Should Know

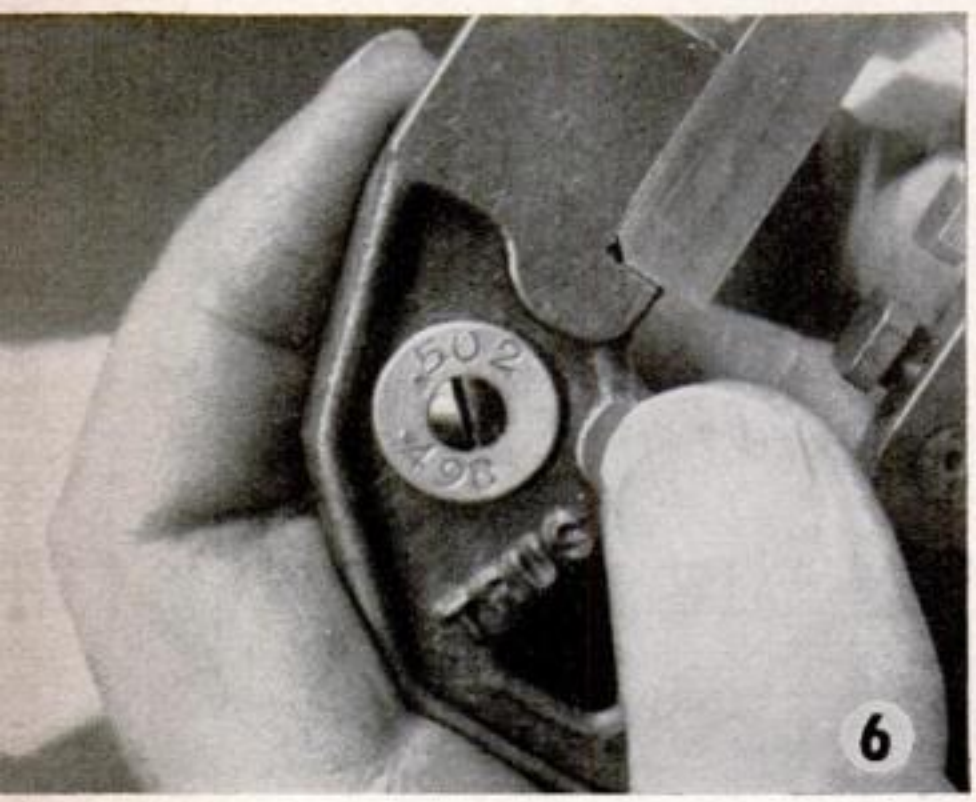


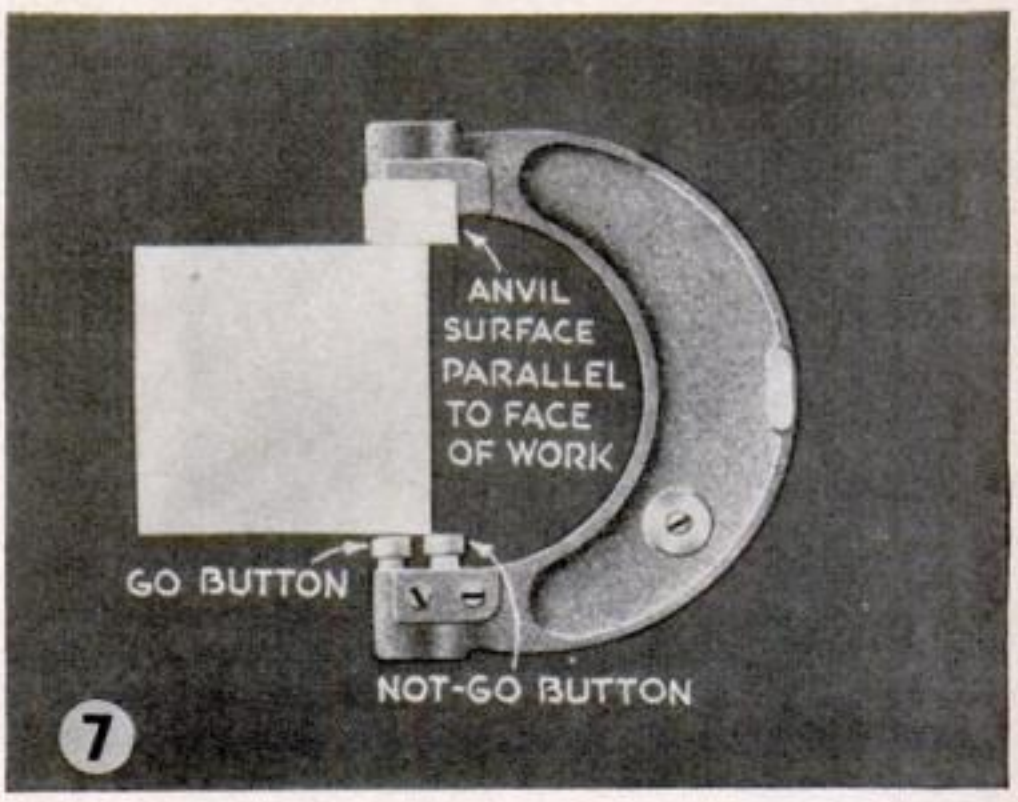
From the U. S. Office of Education training film, "Fixed Gauges"

This article is based upon one of a series of 16-mm. sound films prepared by the U. S. Office of Education for training war workers and distributed for the Government by Castle Films. For the machine-shop student or beginner, the value of these motion pictures cannot be overstated. They explain in the simplest and most graphic manner the operation of the standard tools and machines used in industry. Make every effort to see these films if they are being shown in your community or in the plant where you work.









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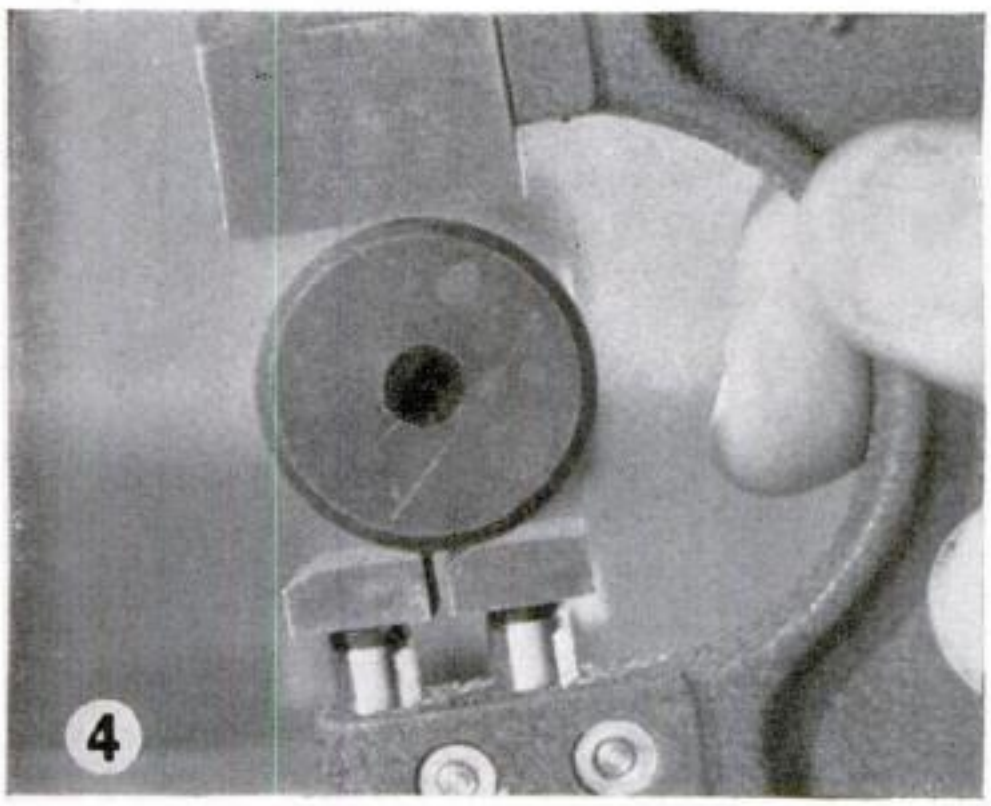
About Fixed Gauges

IF YOU were building a machine and accidentally bored a hole in a certain part .010" oversize, you could perhaps save the part from the scrap pile by turning the shaft or other piece that is to fit the hole also .010" oversize. However, if the shaft were to be made by another operator, working from a blueprint, he would presumably turn it to the size specified, and it would not fit. The part bored oversize would be worthless.

Again, suppose that you alone were building not one but 100 identical machines, and bored a single part oversize. In turning a single shaft oversize to fit it, you might have to alter tool settings, change jigs, or take other special pains to make it larger than the other 99. Also, the oversize bore and its shaft would have to be identified and kept separate from the others to insure their being assembled together. Adjoining parts, too, might have to be altered so as to fit.

In making machines by modern mass-production methods, be they tanks, automobiles, guns, or kitchen mixers, interchangeable parts are a "must." Automatic machinery cannot be set to turn out a single oversize shaft in a batch of thousands. Nor can the assembly line wait while a worker tries half a dozen parts to find one that fits properly. Furthermore, the risk that an ill-fitting part may actually be used, only to give trouble later, must be eliminated. It is also necessary that parts made in different divisions of the shop, or in plants miles apart, fit together accurately.

Interchangeability is the answer to all these problems. All parts of one kind must be so nearly identical that any of them will fit. They must be manufactured to certain standards of precision, and checked with measuring tools to make certain that they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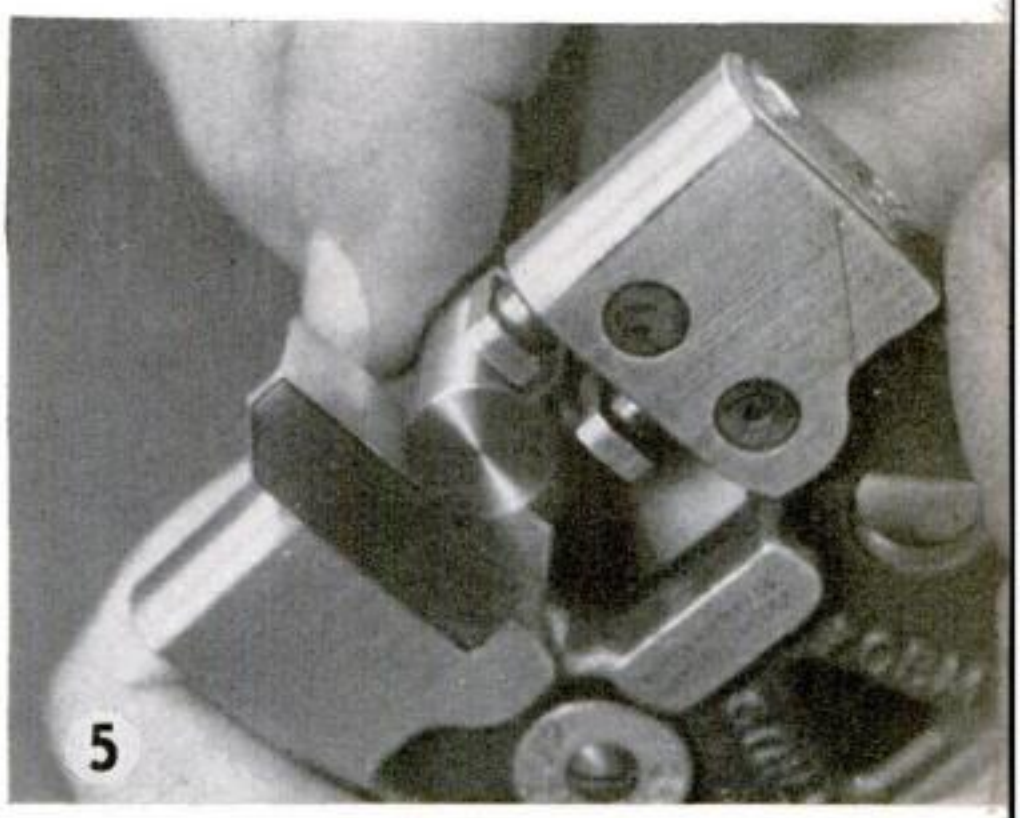
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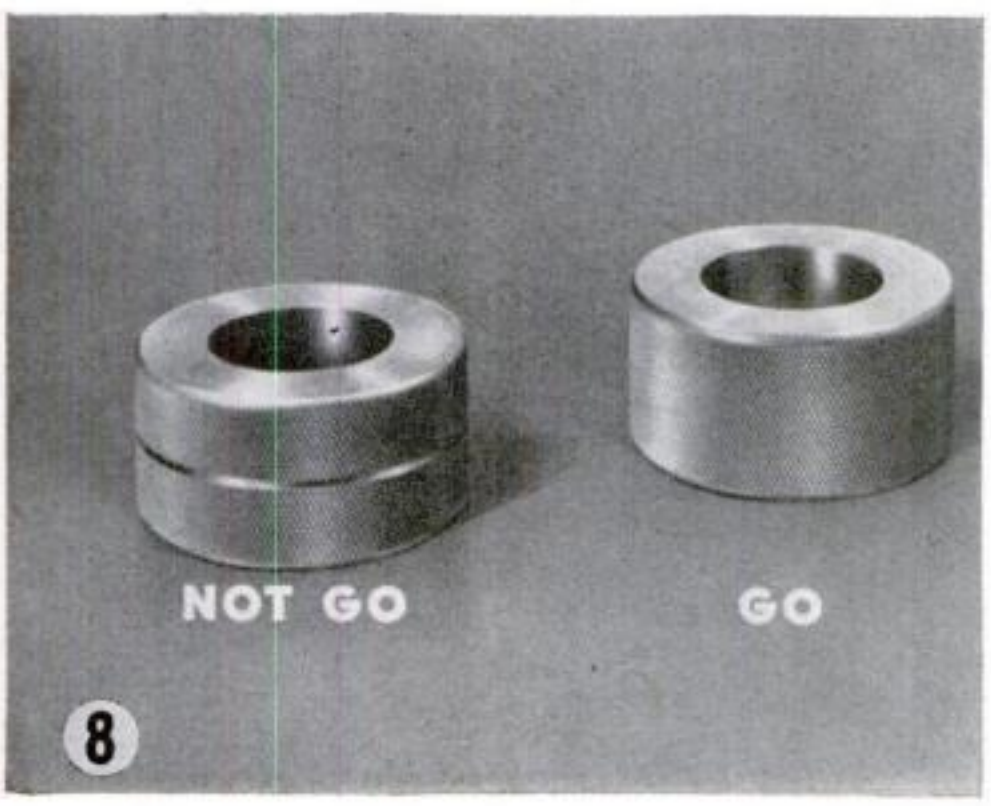

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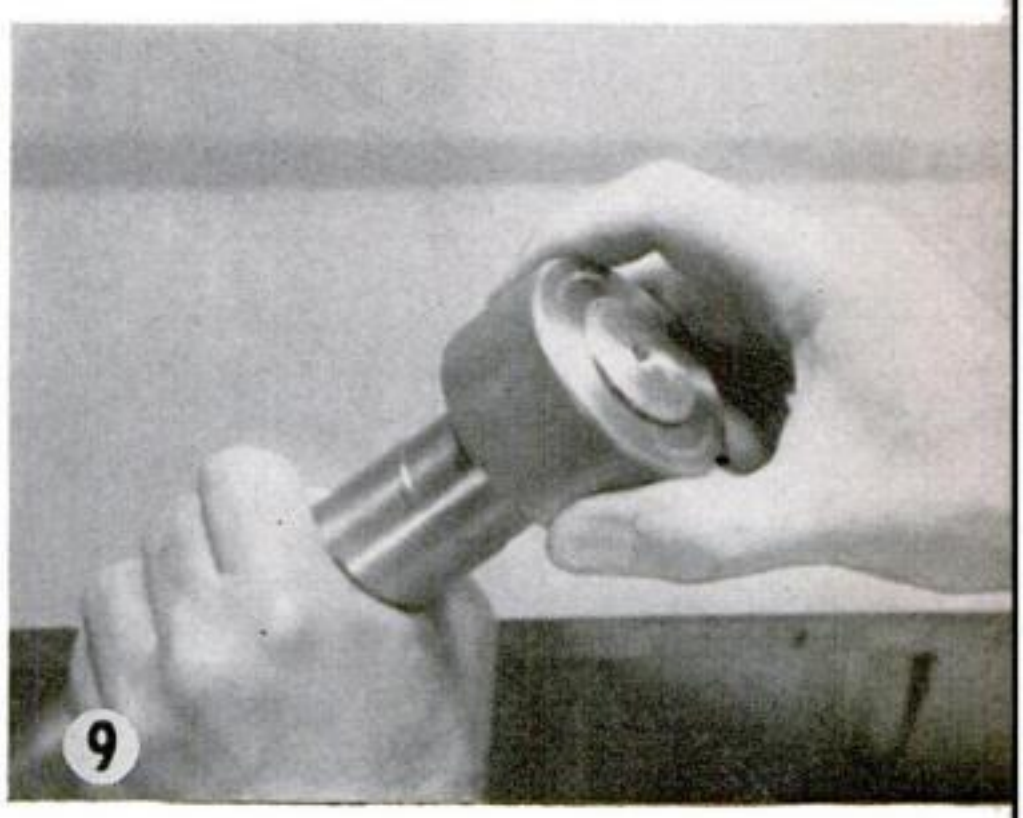
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come up to those standards, before they are ready to go to the assembly line.

Where a great many similar parts must be measured rapidly, fixed gauges, which are not adjustable during use, are more efficient than micrometers or other adjustable instruments. Some fixed gauges, like the snap gauge shown in Fig. 1, can be adjusted within a narrow range, but once set they remain fixed.

A great many of the measuring tools used in mass production are fixed gauges. A plant may have hundreds of kinds and sizes, each for measuring some particular part.

In giving critical dimensions, blueprints usually state the tolerances permitted, that is, the limits of accuracy to which the part must be made. The diameter of the piece shown in Fig. 2, for example, is given as 1.250″ plus zero and minus .0005″. This means it must not be larger than 1.250″ nor smaller than 1.2495″. A snap gauge like that in Fig. 1 can be used to check the dimensions of this piece within the limits given.

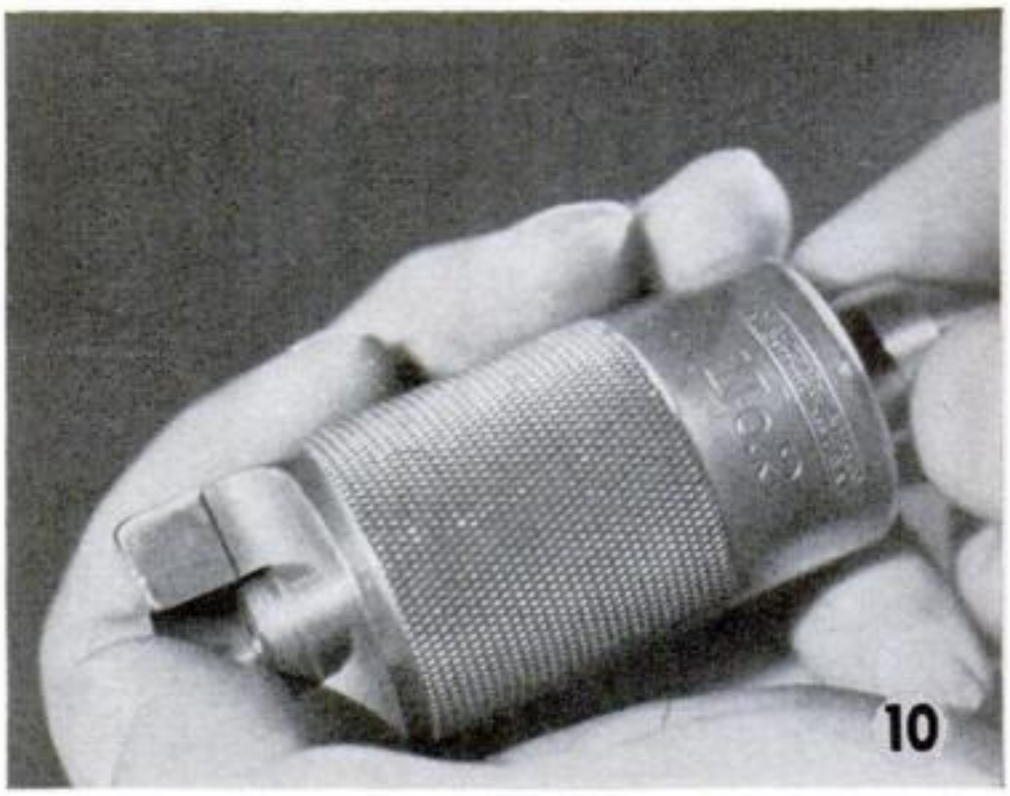
Such a snap gauge has a flat gauging surface called the anvil fixed in one jaw (Fig. 3), and two gauging buttons in the other jaw. These can be set in the gauge room but remain fixed during use. The outer one, called the "go" button, is set the maximum dimension from the anvil (1.250″ in the example given). The inner one, called the "not-go" button, is set at the minimum dimension, in this case 1.2495″. The difference of .0005″ is the tolerance the gauge will allow—the same permitted by the blueprint.

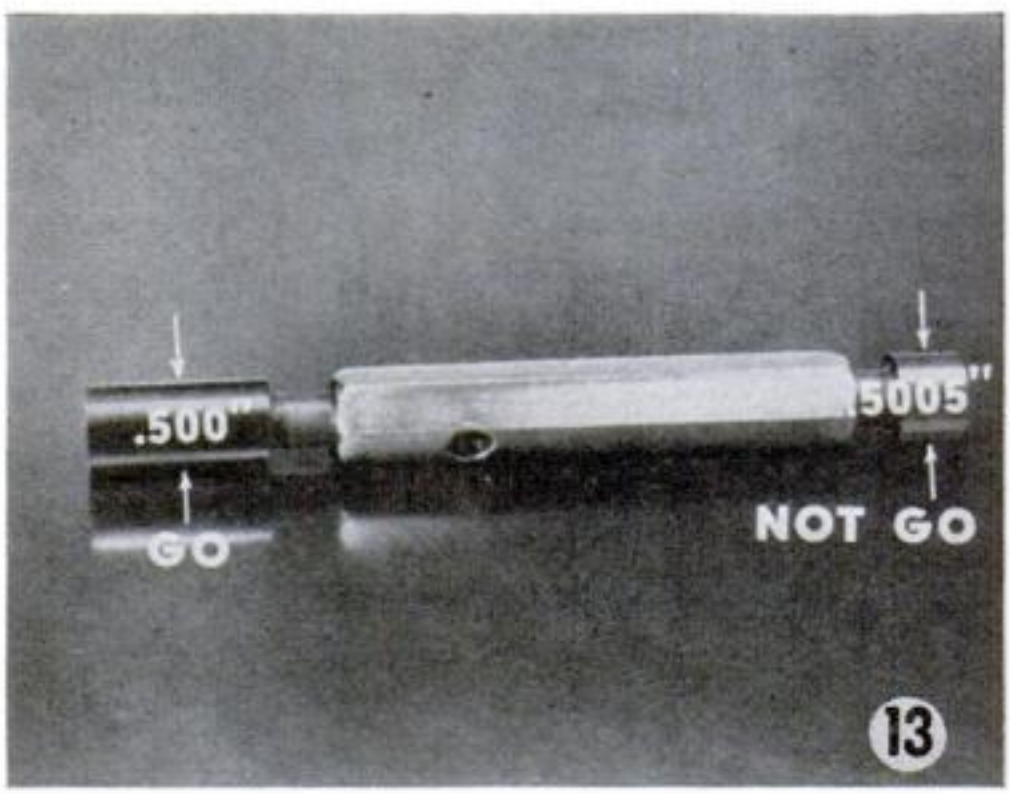
Figure 4 shows the gauge in use. It is held square with the work, the anvil placed gently on the work, and the other jaw pushed under the piece with a smooth, rolling motion.

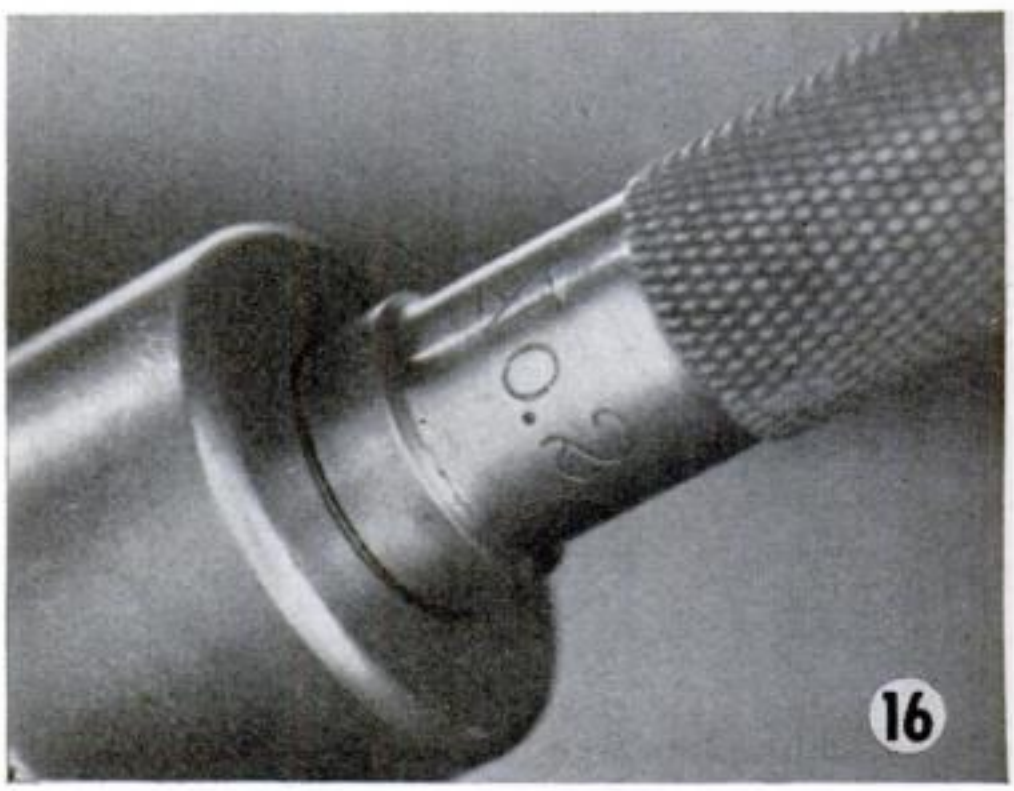
If the go button passes the work and the not-go button is stopped, the piece passes inspection. Should the not-go button also pass, the work is undersize. If the go button does not pass freely, the gauge should not be forced. As this button is set to the maximum dimension, the piece must be oversize. Forcing the gauge will pass work that should be rejected, and may damage the anvil or button surfaces, making the tool useless for precision measurement.

Small parts should be gauged as shown in Fig. 5—by rolling them gently into the gauge and under the go button. If the piece is stopped by the not-go button, its diameter is within the tolerance allowed.

Snap gauges are marked with the sizes to which the buttons are set. The one shown in Fig. 6, for example, will gauge work within a tolerance of .004″. The marking disks are affixed in the gauge room and should not be removed elsewhere.







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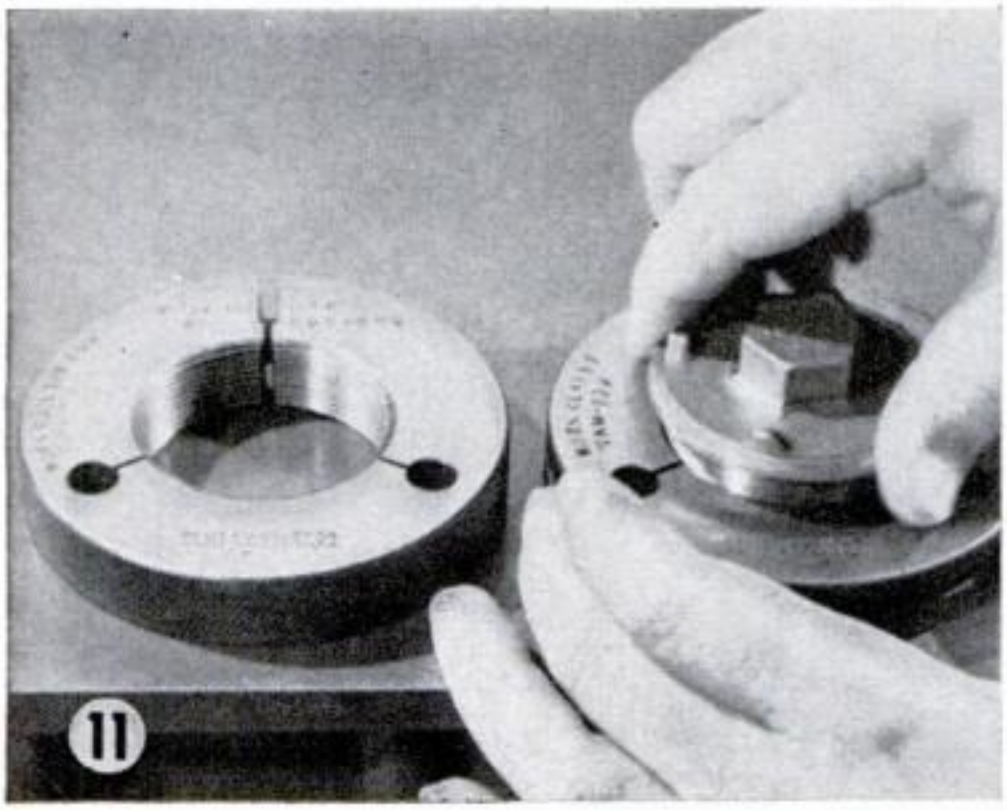
Distances between parallel surfaces also can be measured with snap gauges (Fig. 7). Bring the gauge up with the anvil parallel to the face of the work. Use only light pressure to push the gauge over. The go button should pass, and the not-go button should be stopped. If the latter also passes, the work is undersize and will probably have to be scrapped.

Adjustable limit gauges such as these can be set correctly only by the use of master gauge blocks. This is done in the gauge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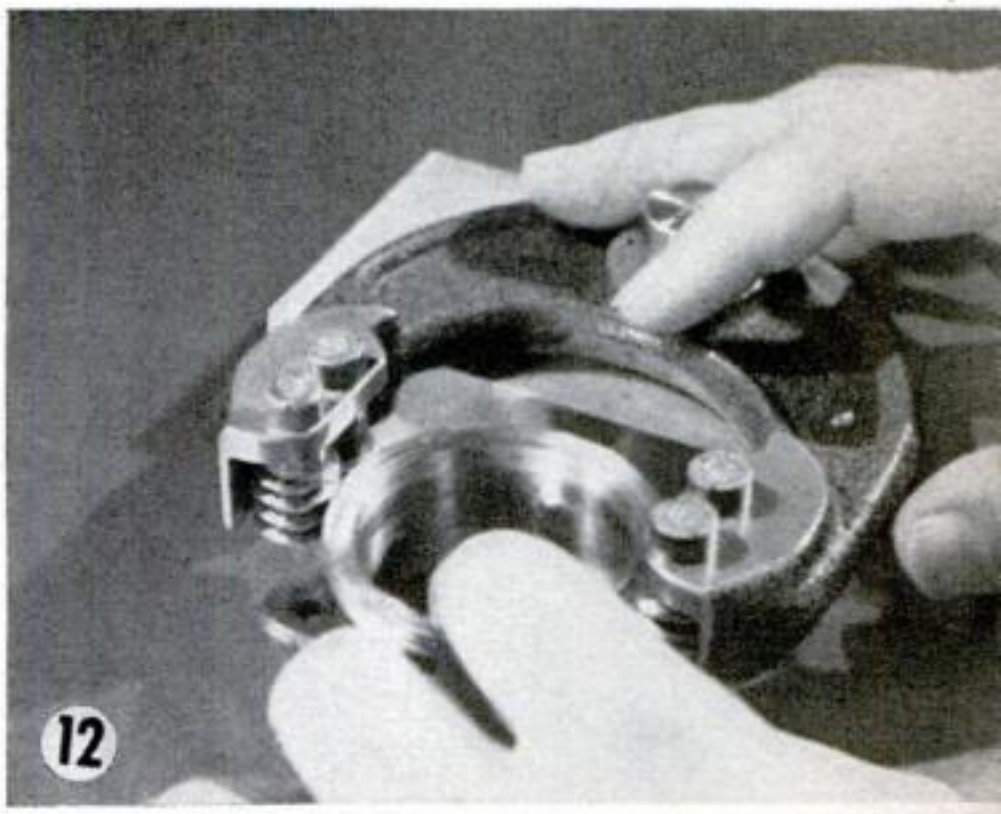
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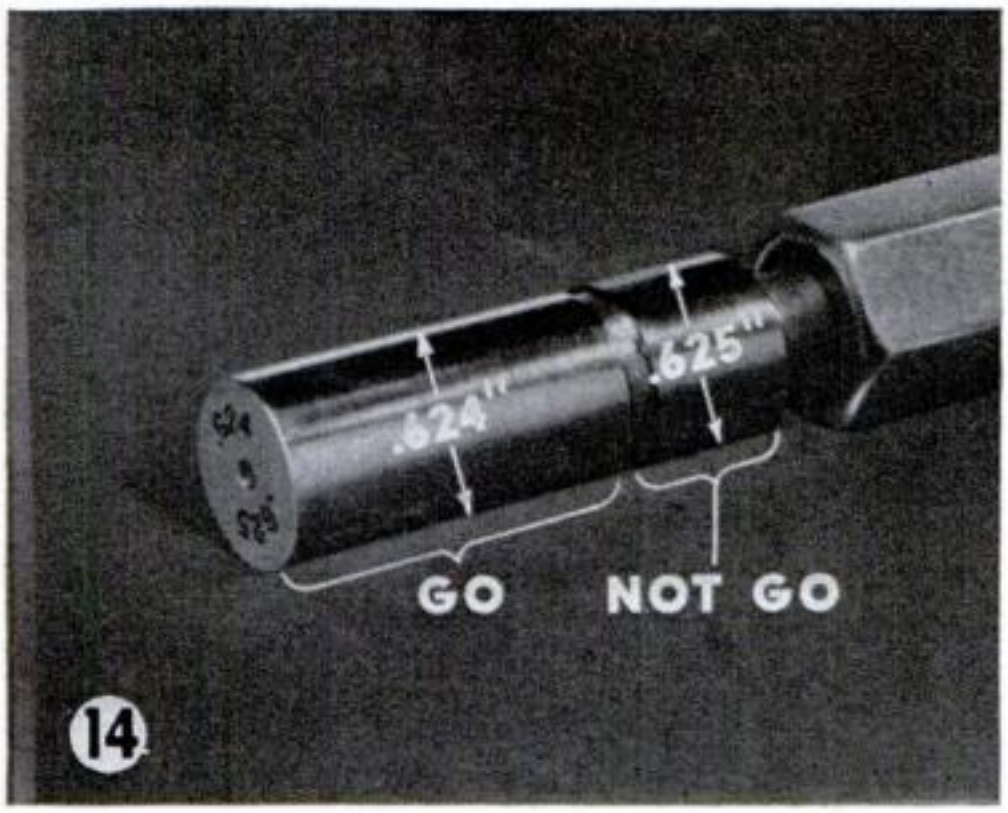

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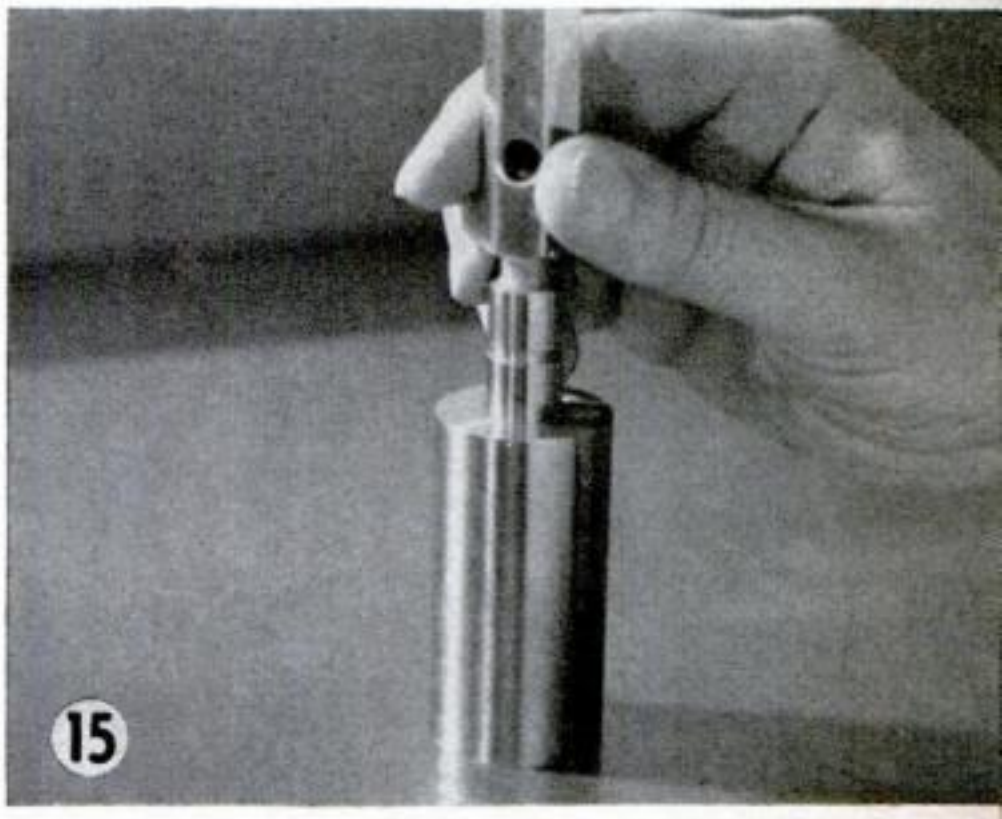
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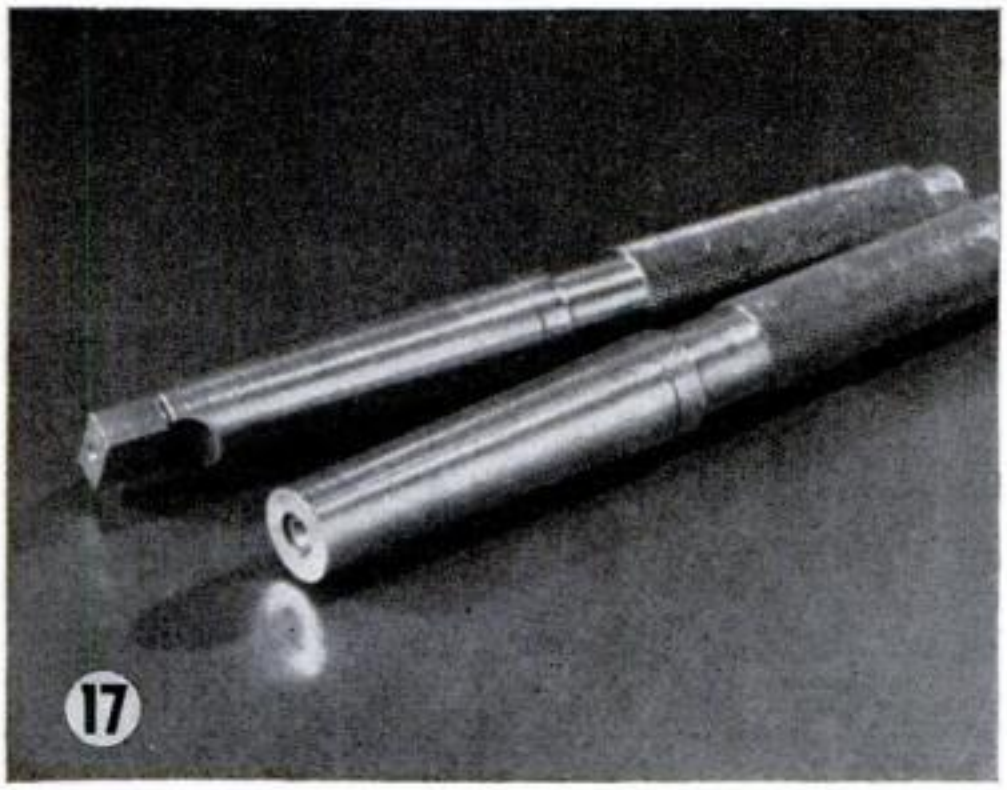
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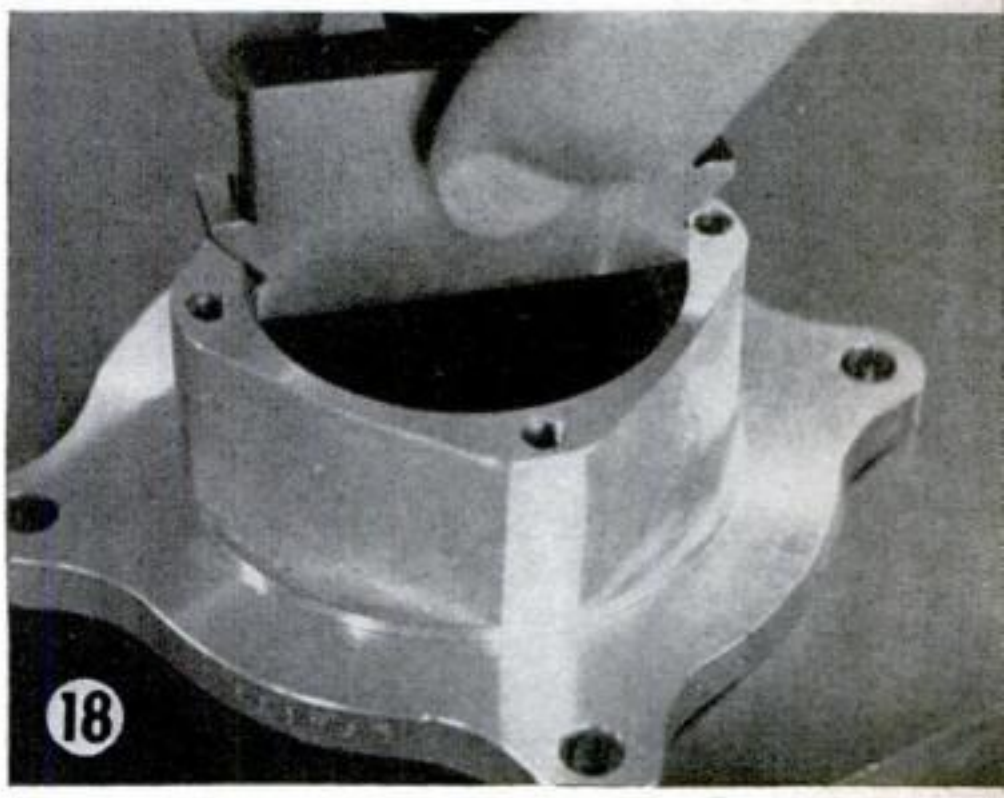
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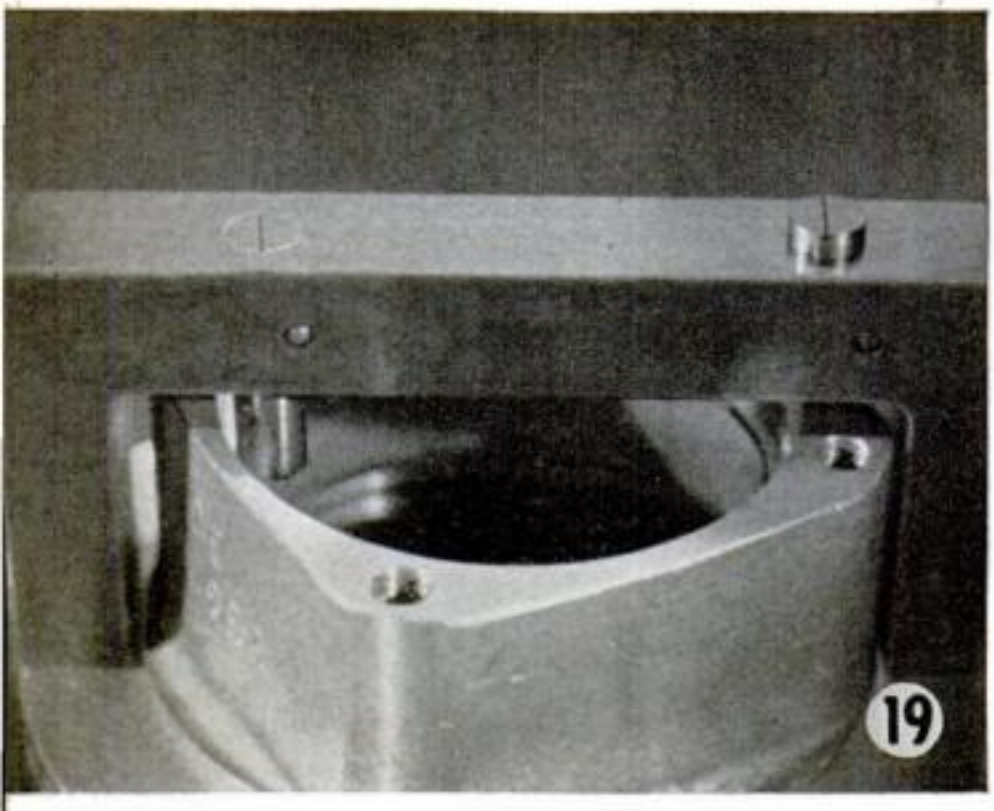

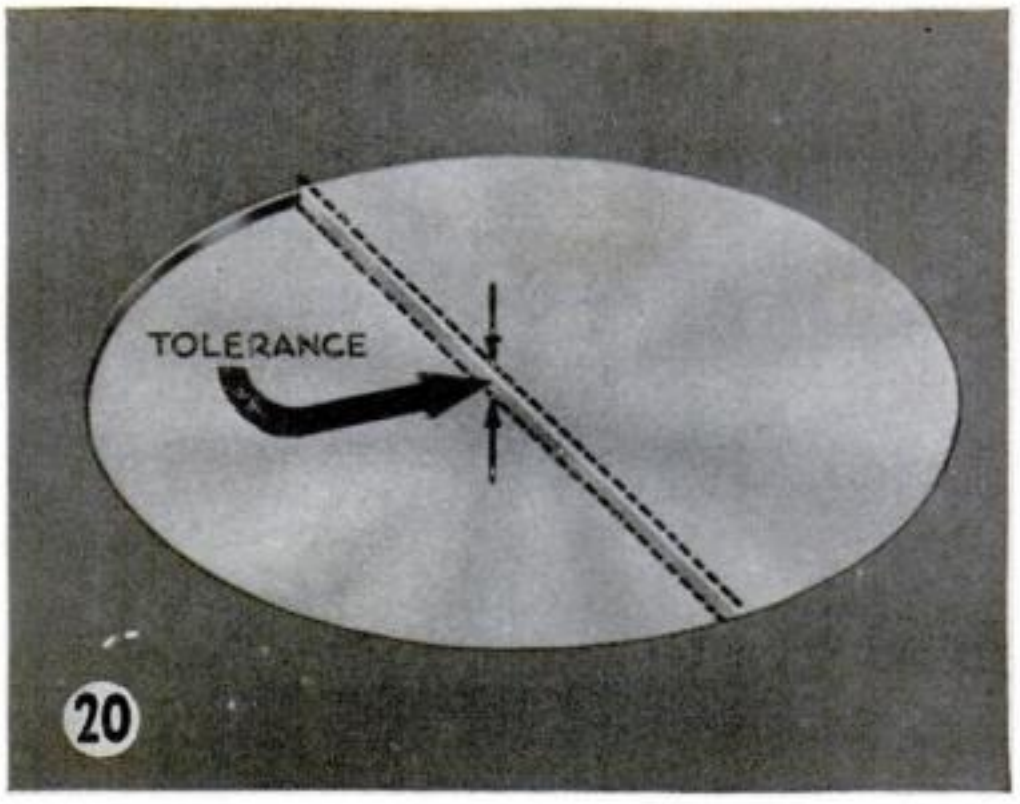

room and should never be attempted by unauthorized persons.

Go and not-go ring gauges (Fig. 8) are used for checking the outside dimensions of round parts. The not-go gauge is readily identified by the groove around it. In use, the go gauge should be brought up to the work straight, and it should go over it without twisting (Fig. 9).

Taper ring gauges are used to check both the size and the angle of tapers. If the work cannot be shaken in the gauge, the angle of taper is correct. When the small end of the work lines up with the limit mark on the gauge, as in Fig. 10, the piece is the right size.

Screw threads are gauged with thread ring gauges, as well as with other types. The work should thread freely into the go gauge, which is shown at the left in Fig. 11. It should not enter the not-go gauge for more than $1\frac{1}{2}$ turns. There must be no burrs on the work, as these might prevent it from entering the gauge.

The roll thread snap gauge (Fig. 12) can be used much more rapidly than most other thread gauges. The work should pass the go rolls freely and, of course, should be stopped by the not-go rolls.

Plug gauges are widely used to check the dimensions of holes. Single plug gauges have only one diameter and are used where work need not be gauged within tolerance limits.

Figure 13 shows a typical double-ended plug gauge, which can be used for measuring a hole to a definite tolerance—in this case .0005". The size of each gauging member is stamped on its end, and the go gauge is longer than the not-go gauge.

The progressive plug gauge has the not-go member immediately above the go member, with a groove separating the two (Fig. 14). If a hole were specified on a blueprint as .624" in diameter, plus .001" and minus zero, the gauge shown could be used to check the work. The go member, being .624", should slip into the hole, but the not-go member should not.

Care in using a plug gauge is necessary to prevent wear and to maintain its accuracy. The edges of holes being checked should be smooth and free from burrs, chips or filings that might scratch the lapped gauging surfaces.

Always slip a plug gauge straight in and out of a hole (Fig. 15) without rotating it. If this is done, less wear results and the gauge remains accurate longer. Once worn beyond the limits allowed in the shop, plug gauges must be discarded, or reground and lapped to a smaller size and so marked.

Taper plug gauges are used to check both the size and angle of tapered holes. If the taper is correct, the gauge will fit the hole without shake; if the hole is the right size, the limit mark—a fine groove encircling the gauge—will just line up with the end of the work, as shown in Fig. 16.

A plain taper gauge and one having a tang at the small end, which serves to check the dimensions of the tang recess, are shown in Fig. 17. Still other taper gauges have the limit mark in the form of a flat.

Large holes are often gauged with flat plug gauges, which are much lighter and easier to handle than round ones of corresponding size. Go and not-go members are on opposite ends, and separated by a groove or a projection (Fig. 18). The go member is always the longer.

Screw plug gauges, used for checking internal screw threads, resemble a screw but have a groove cut the full length of the thread on the go end to clear chips out of the thread being gauged. This end should enter the hole freely and should always be run down to the bottom. The not-go end

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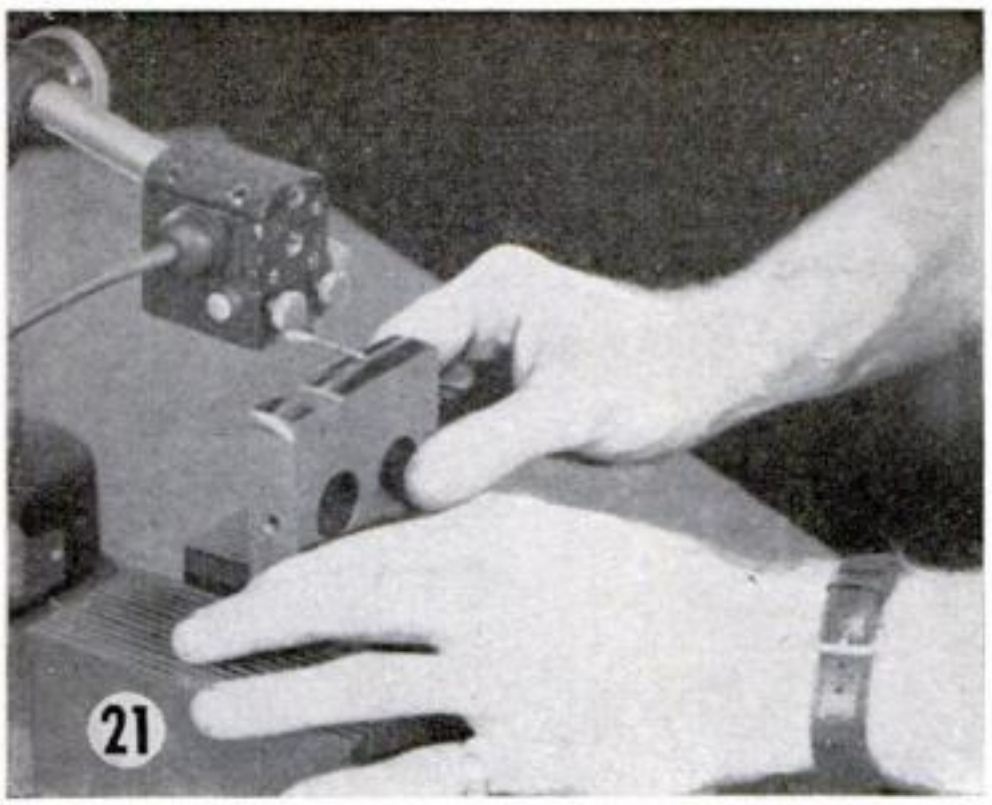

should not enter the hole more than 1½ turns.

Flush-pin gauges are usually made up in special shapes and sizes to check depth dimensions on specific parts. The one in Fig. 19 is used to gauge the distance between an outside and an inside flange. It is placed in position and the pins are pushed down against the inner flange surface. A fingernail is then run over the tops of the pins, which are cut step fashion as shown in Fig. 20. The lower step must be flush with or below the top surface of the gauge; the upper step must be flush or above the surface. The difference between them is the tolerance the gauge allows.

Slow wear is inevitable, and therefore gauges must be checked periodically with master gauges or blocks. Modern manufacturing plants maintain gauge-control or inspection departments where these and other measuring tools are checked and adjusted.

Gauge blocks, used for checking, are rectangular pieces of steel finished to specific sizes within limits of a few millionths of an inch. They come in sets, and can be used in combination to make up a great many different sizes, depending upon which are used.

Snap gauges can be adjusted by setting the buttons up directly against gauge blocks placed between the jaws. Plug gauges and others can be checked indirectly by placing the required combination of gauge blocks under the arm of an electric limit gauge or comparator gauge and noting the dial reading of this sensitive instrument. The blocks are then removed and the gauge under test is inserted for comparison. The dial reading will vary if the gauge is as little as .00005" smaller or larger. Figure 21 shows a large flat plug gauge being checked in this way.

Gauges are manufactured to various limits of accuracy, according to the purpose for which they are to be used. Some are made within .00002" of their rated size, but working gauges are manufactured to larger tolerances, as shown in the table above.

FINISH STANDARDS FOR CYLINDRICAL GAUGES

Sizes up to and including	Class XX	Class X	Class Y	Class Z
.825"	.00002"	.00004"	.00007"	.00010"
1.510"	.00003"	.00006"	.00009"	.00012"
2.510"	.00004"	.00008"	.00012"	.00016"
4.510"	.00005"	.00010"	.00015"	.00020"
6.510"	.000065"	.00013"	.00019"	.00025"
9.010"	.00008"	.00016"	.00024"	.00032"
12.010"	.00010"	.00020"	.00030"	.00040"

Class **XX** gauges are precision lapped. Used for master or set-up standards.

Class **X** are precision lapped to close tolerances. Used as master gauges and as highest quality inspection and working gauges.

Class **Y** are manufactured with a good lapped finish to slightly larger tolerances. Used for working gauges.

Class **Z** are ground and polished to a good commercial finish, but not fully lapped. Used as working gauges where tolerances are fairly generous.

Centering Work in Your Lathe to Get Surface Running True

CENTERING finished bar stock or previously turned work so that the finished surface runs exactly true is virtually impossible by the usual punch-mark and center-bit method. It can easily be done as follows:

Grip one end in the chuck and adjust it to run true. Set up the steady rest close to the chuck and adjust it to bear on the work; then clamp it in place at the free end of the work. Face off the free end and work a small pit in the center with a sharp-pointed tool. Set the drill chuck in the tailstock, insert a center bit, and start the bit in this small pit. The work is then turned and the other end centered in the same way. Even closer results may be obtained by using an ordinary drill in place of the center bit, then slewing the compound slide around to 60 deg. and working out the center with a sharp-pointed turning tool. Care must be taken to set the point of the tool at the exact height of the lathe centers. If the job is carefully done, work can be centered to within .0005".—J. S. MORREL.

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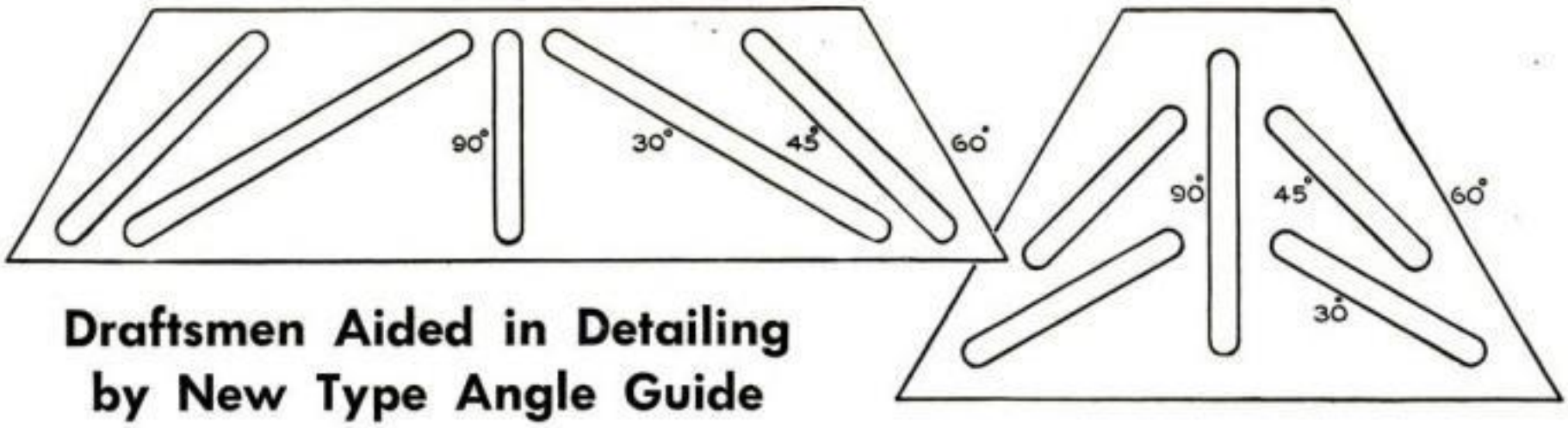
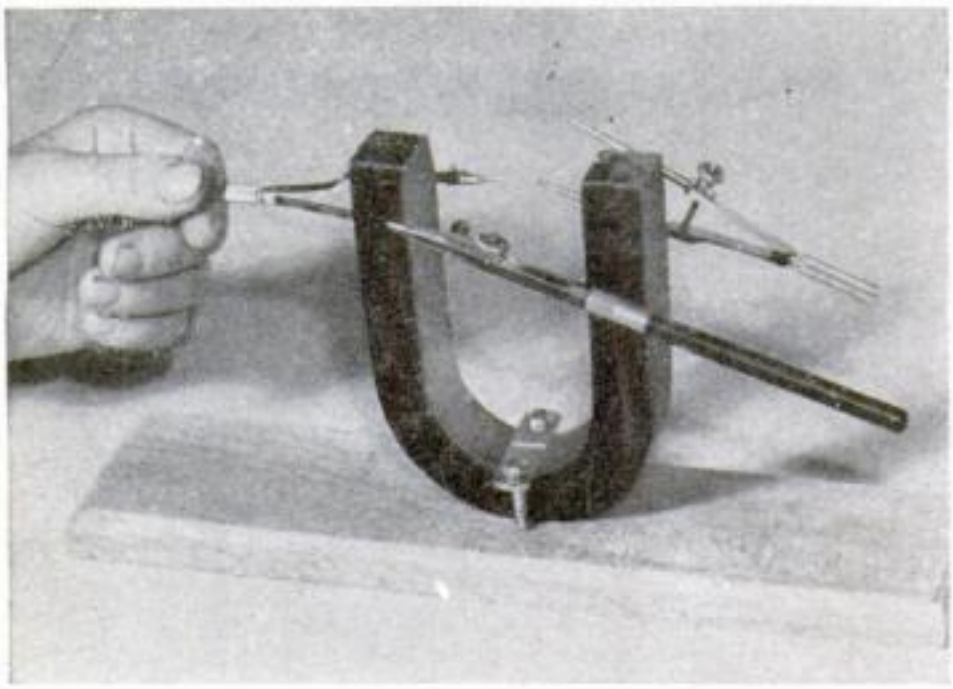


Draftsmen Aided in Detailing by New Type Angle Guide

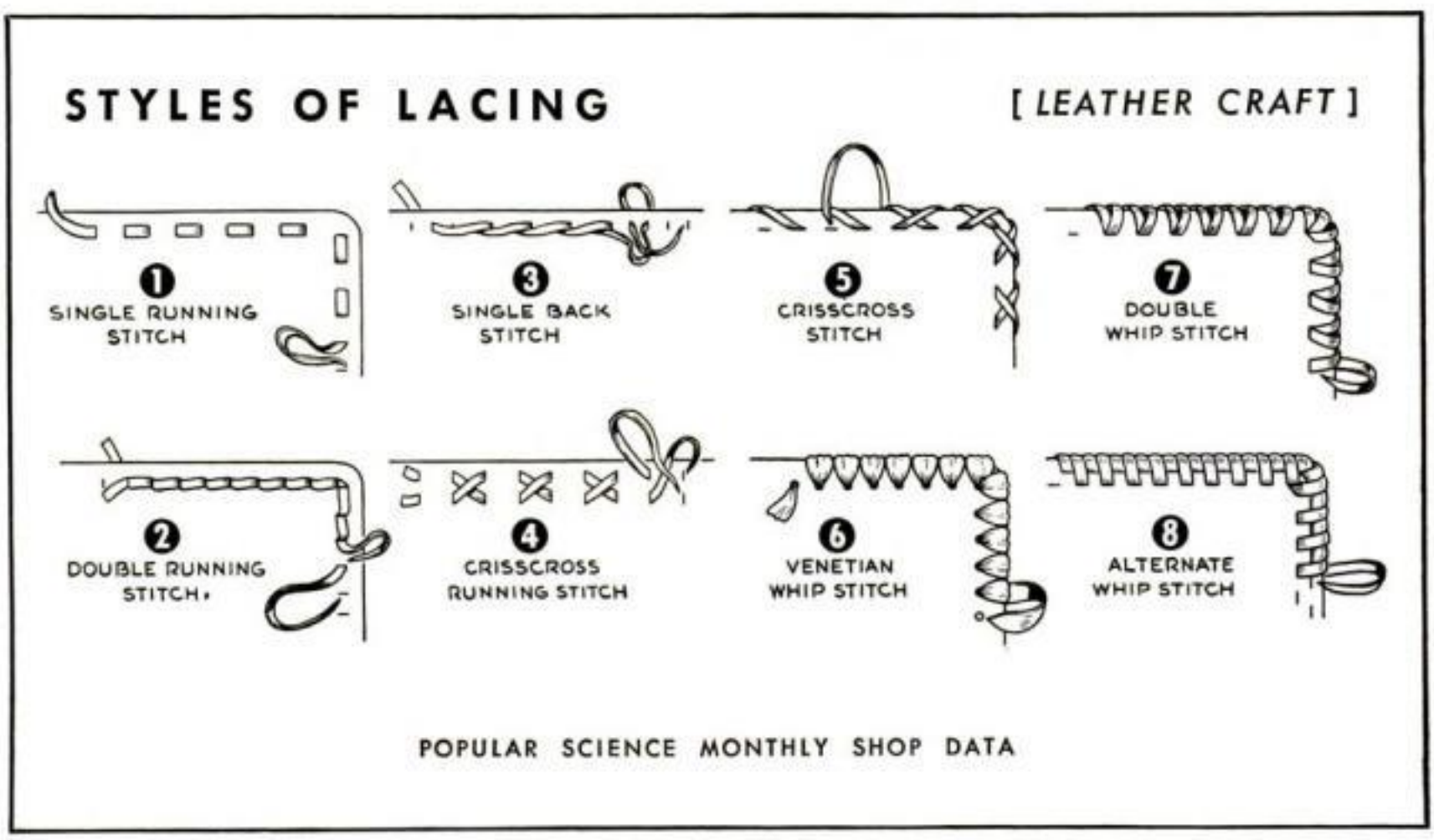
SPEED in drafting can be increased by using a guide with fixed angles on both sides of the vertical to draw small details such as hexagonal nuts, small polygons, and symbols. Ordinary triangles must be constantly lifted and reversed, but the handy all-purpose angle of which two types are shown above will draw 30-deg., 45-deg. and 60-deg. angles both ways without being turned over. The angle is simply slid along the T-square to bring the proper slot into use. Cut the guide out of thick celluloid, plastic, or thin plywood.

This device can also be used in drawing 15-deg. and 75-deg. lines by placing the 60-deg. edge along the T-square and using the 45-deg. slots. When inking, slide another triangle or thin ruler under the T-square and partially under the angle so that it rides up away from the drawing.—R. W.



Magnetic Instrument Holder for the Drafting Board

DRAFTSMEN who occasionally drop or mislay their instruments will find the magnetic holder shown at the left a real convenience and a timesaver when a rush job is to be turned out. It consists simply of a large horseshoe magnet (obtained from an old-style radio loud-speaker) clamped to a baseboard by a metal strip and two wood screws. The drawing instruments need only be "handed" to the magnet to adhere of themselves.—H. RADZINSKY.



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William T. Morris, first home worker to win the Maritime Commission "M," with Admiral Vickery and Assistant Postmaster General Myers

WHAT YOU CAN DO FOR VICTORY

Above, Morris leaving home in uniform for a day's work on his mail truck. At left, in his shop with one of the spokes that made him famous

Popular Science Reader Wins Maritime Award

THE first home workshop to win the "M" award and the "Victory Fleet" pennant of the Maritime Commission for outstanding war production is that of William T. Morris, of Oceanside, Long Island, N. Y., a POPULAR SCIENCE subscriber. He was presented with these at his home by Rear Admiral H. L. Vickery, vice-chairman of the Maritime Commission, in the presence of Assistant Postmaster General Walter Myers and 2,000 neighbors.

Morris is 32 years old, is married, has two children, and drives a U. S. Mail truck. He became interested in woodworking through a WPA class in handicraft in 1934, and in spare time made furniture, lamps, and toys. In August, 1941, he began making marine steering-wheel spokes for a firm in nearby Amityville, and has made more than 12,000 spokes, as well as handles for bronze steering wheels, flagpoles for boats, and parts for a boarding ladder. He turns out an average of 60 spokes a day. His shop equipment consists of a lathe, circular saw, band saw, jig saw, drill press, sander, grinder and five electric motors.

"Sometimes I work from 4:30 to 10:30 P.M., with an hour out for dinner," he said. "Sometimes I stop earlier, and occasionally I take a night off. I put in a good day on Saturday afternoon and Sunday morning."

Besides being a reader of POPULAR SCIENCE, he was one of the first home workers to fill out this magazine's war-work registration form.

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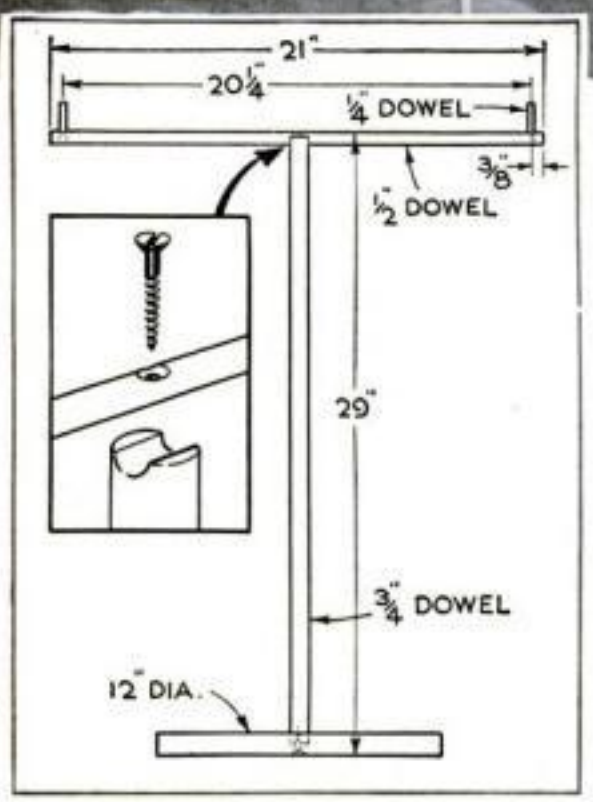

Red Cross volunteers in Long Beach, Calif., use racks to hold gauze for surgical dressings. These "parrot perches" would help many local chapters. Left, diagram showing how to make racks

Gauze Racks

HOMEMADE EQUIPMENT NEEDED IN

By CHARLES HENRY HUNT

President, Long Beach Homecrafters

THOUSANDS of women are working in the production rooms of Red Cross chapters making surgical dressings, gowns, kit bags, and other supplies for our armed forces. Simple equipment built by home craftsmen or school shops can render their task easier and increase production of these much-needed articles.

Most such equipment can be made of wood, and mill scraps can often be used to advantage. The power tools found in the average home workshop will turn out these simple pieces rapidly.

The racks illustrated (called "parrot perches" by the workers) are used to hold gauze for surgical dressings. Several hundred of these racks made by Long Beach, Calif., home craftsmen are in daily use and have proved most helpful.

Cut the base out of ¾" plywood on the band saw or jig saw, using a circle jig. Shape the edge with a cove cutter on a shaper or drill press, or round it with a file and sandpaper. Drill a ¾" hole in the center halfway through; then drill a ⅛" hole and countersink it from the bottom.

The upright is a ¾" maple dowel 28½" long secured in the base with a 1½" wood screw and a little glue. A ½" hole is drilled near the top, and a cut is made across this hole, forming a semicircular notch for the crosspiece. This is a 21" length of ½" dowel fastened to the upright with a single countersunk screw. Fill the hole above the screw with plastic composition wood to give a smooth, round working surface.

Stain the base and upright walnut or light oak, apply a lacquer sealer coat or thin shellac, rub lightly with steel wool, and wax. The crosspiece should be enameled white so that it can be washed. Chapter designations and the Red Cross insignia can be burned in or painted on.

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Shock blocks, shown in use above, are also in great demand among home-nursing workers. Easily made of mill scraps, they lift up beds at one end for shock patients. Four will raise a bed to hospital-cot level

and Shock Blocks

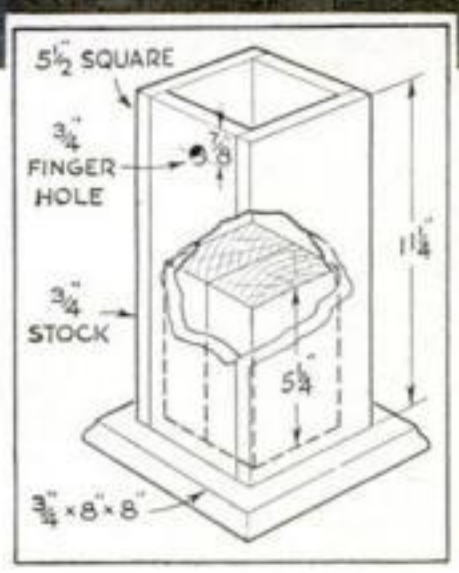
QUANTITY BY RED CROSS WORKERS

Shock blocks are being used in thousands of home-nursing classes, and are standard equipment for all civilian-defense emergency centers. Every home should have two of them. They are used for shock patients to raise one end of the bed.

The shock blocks are so constructed that the bed feet can be set inside them. Four of them will raise a standard bed to the height of a hospital cot, making it much easier to care for a patient.

Mill scraps can be used to advantage in making a large number of the blocks. Nail two 2" by 4" pieces 5¼" long firmly together. Cut two pieces 4" by 11¼" from ¾" stock and nail these to the blocks; then cut two other ¾" thick sides to overlap the first. Bore a ¾" hole in one side as a finger hold. Nail these sides on, round off all edges well, and sandpaper to eliminate splinters.

The base has a rounded edge, which can be filed or run on a shaper. Nail the base firmly to the box with sixpenny nails. Give the blocks a coat of stain and seal this with lacquer or thinned shellac. When this is dry, rub with steel wool and wax. If preferred, the blocks can be painted white.



Little devices such as those described above are simple enough to make, and often prove indispensable in volunteer work or in caring for the sick. If you have a home shop, consult your Red Cross chapter to learn what is most needed.

Transparent Cellulose Tape Solves Erasure Problem

OFTEN temporary markings, such as dates of revision or quantity designations, are needed on blueprint tracings. Since ink erases badly from a tracing, these markings are usually made directly on the blueprint, but this is a nuisance if several copies are involved. It has been found that ordinary transparent cellulose tape takes ink quite well. A strip can be placed on the tracing cloth, in the desired position, and filled in with the lettering needed. Later the tape can be quickly peeled from the tracing, accomplishing the "erasure" in short order.—A. A. MERRILL.

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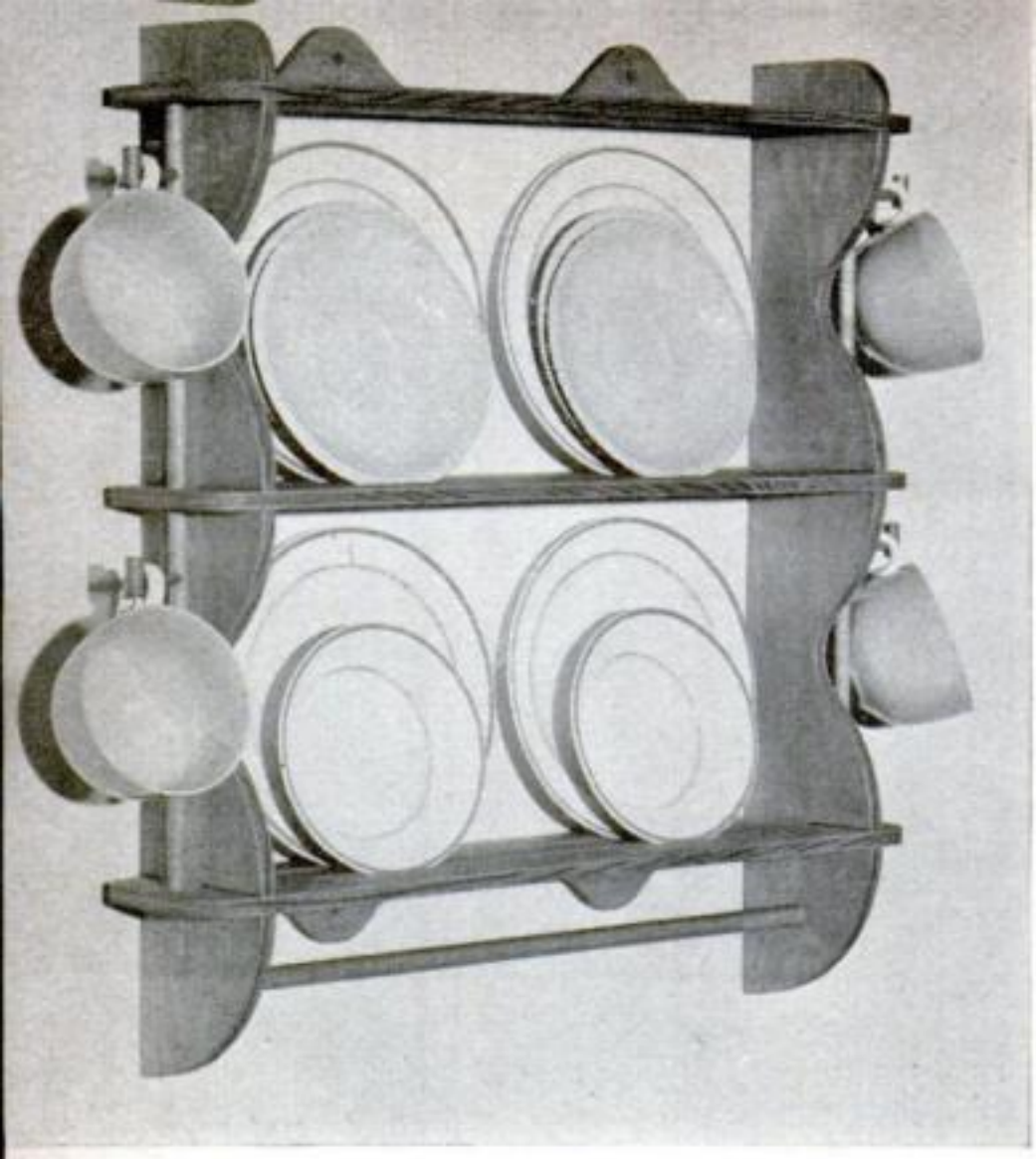
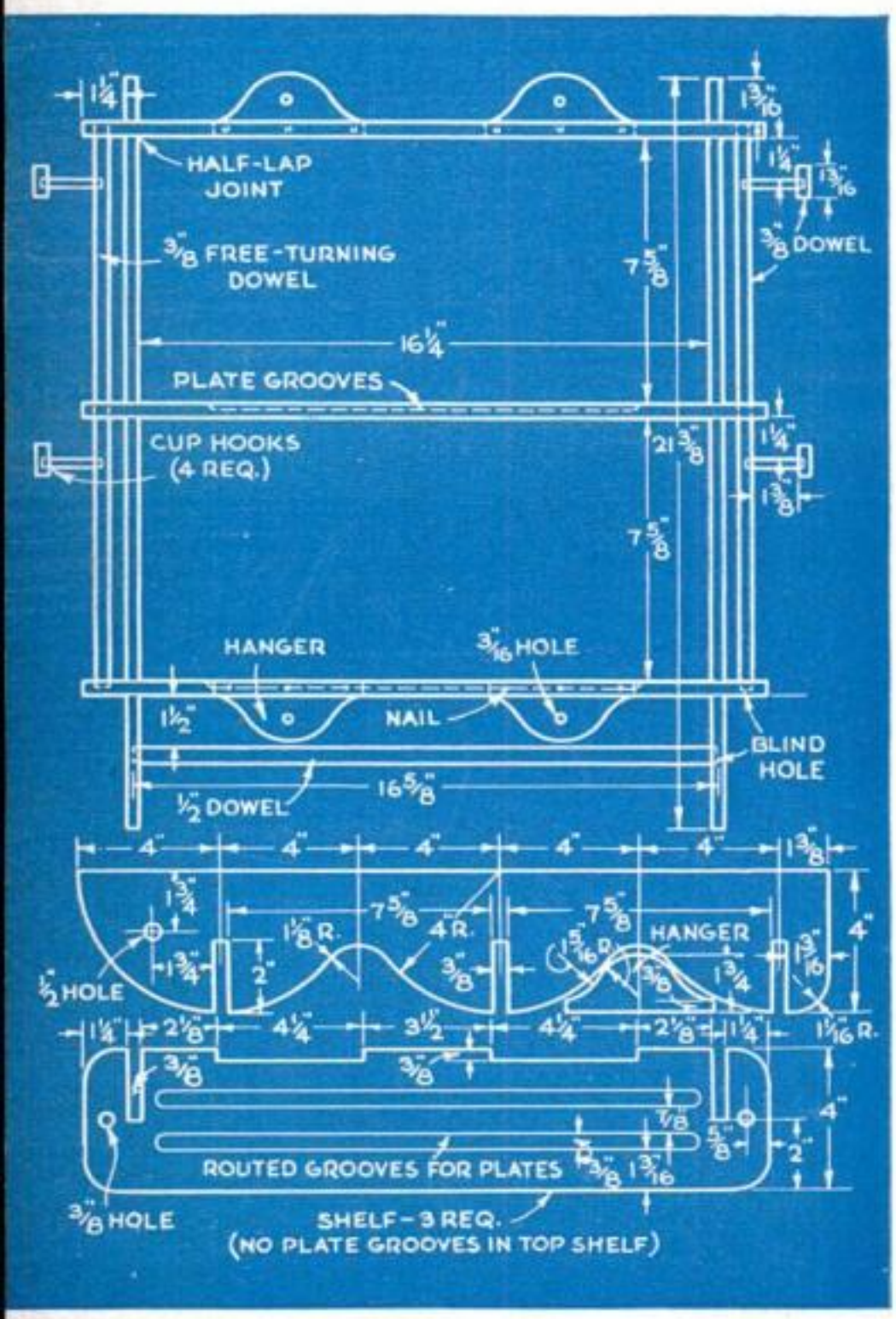
Craftwork

A LITTLE WOOD ATTRACTIVE



This simply made wall unit, built of fir plywood, is designed to hold all the breakfast dishes for four persons and can be placed wherever you wish



BREAKFAST SHELF. This decorative hanging unit makes it possible to group together the related dishes for breakfast for four persons. Not only does it save space, but the rack can be placed at whatever spot is most accessible in the kitchen.

The parts are of ⅜" fir plywood, with half-lap joints where side walls and shelves intersect. The shelves are evenly spaced 7⅝" apart. All except the top shelf have two parallel, routed grooves 3⁄16" by ⅜", placed ⅞" apart, into which the plates and saucers are set. The shelves overhang at each side 1¼", which gives ample material for the joint as well as for a ⅜" vertical, free-turning dowel. This rod rests in a 3⁄16" deep hole in the bottom shelf. The horizontal arms are ¼" dowels, and they have short pieces of ⅜" dowel glued on their ends to form safety hooks for the cups. When hanging, the cups can be turned to rest conveniently in the curves of the side walls. The top overhang acts as a ledge for sugar bowl, creamer, and the like.

Four curved hangers are cut from the waste of the side walls and are set flush into the rear edges of the top and bottom shelves. A towel rack of ½" dowel is lined up between the lower extremities in 3⁄16" deep holes, 1½" below the bottom shelf.

In assembling, first join the walls and shelves together after fitting in the towel-rack dowel. Make sure all the holes are lined up for the side dowels; insert them and glue in the "pipestem" cup hooks in predrilled, lined-up ¼" holes.

Sand all curves and corners smoothly. Mix a stain of vermilion in oil and turpentine, apply freely, and wipe dry. When this has dried thoroughly, apply clear varnish, rub when dry, and give a second coat of varnish. Working time: 4½ hours, exclusive of staining and varnishing.

WOVEN-WOOD SERVER. Many requests for a good tray are answered in this woven-wood design, which is of strong construction and fine appearance. The handles can be grasped easily, and spilling is prevented by the dowel rails.

Rip enough strips of straight-grained pine, 3⁄32" by 7⁄16", to weave a wood mat for an overall size of 11¾" by 15 13⁄16". In weaving, wet the wood in hot water and line up the long strips against a straightedge on a clean board, spacing them 7⁄16" apart. Secure

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Planned to Save Materials

GOES A LONG WAY IN MAKING THESE TWO PROJECTS DESIGNED BY ERNEST R. DEWALT

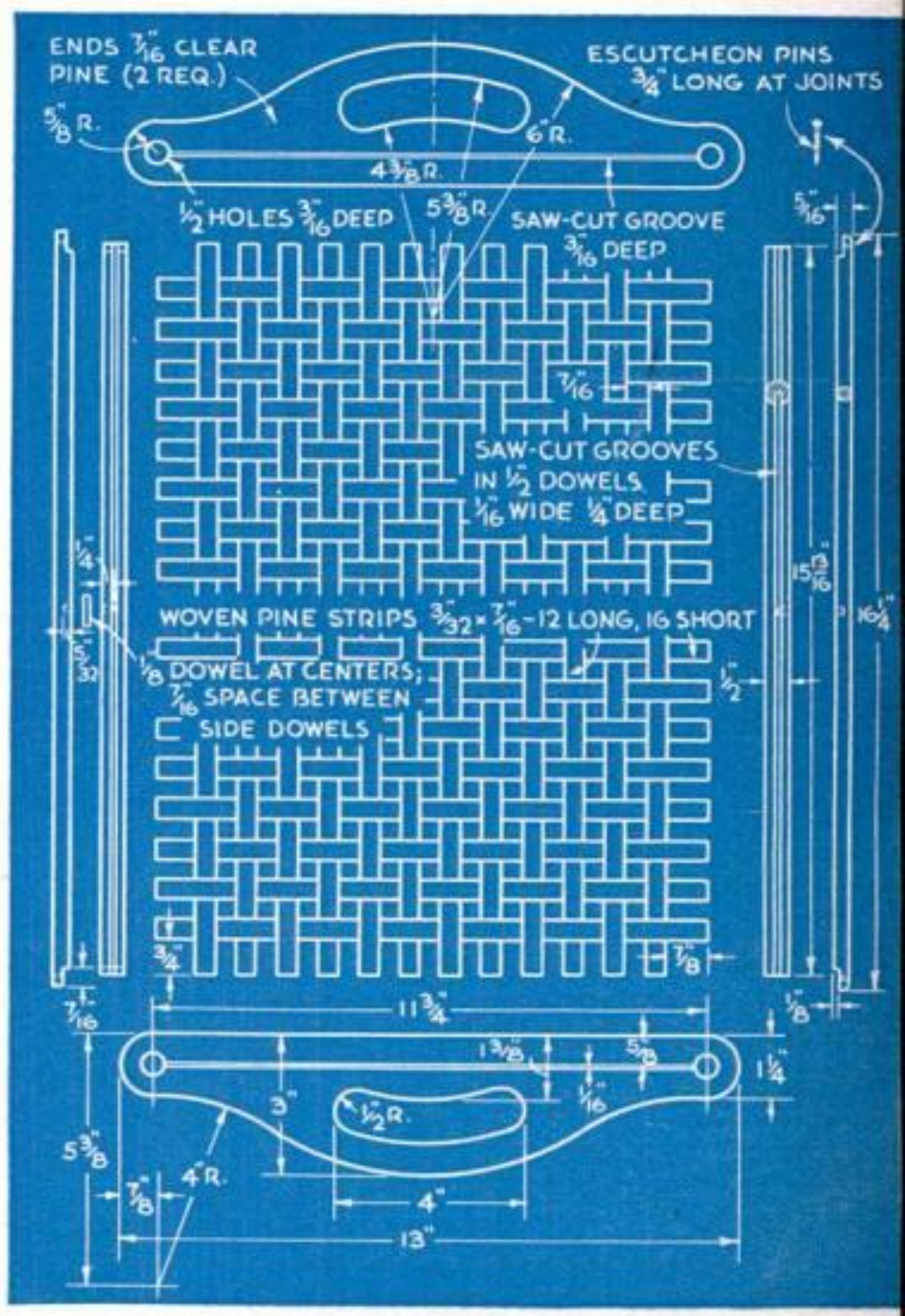
them with a holding cleat nailed to the board in the spaces. Start weaving at a line ¾" from the straightedge and space the shorter strips 7/16" apart, keeping the outside spaces (after clipping the excess wood) to ⅞".

Cut two ½" dowels 15 13/16" long for the sides, and run a saw-cut groove in them 1/16" wide and ¼" deep. For the upper rails use two 5/16" dowels 16¼" long and cut ⅛" by 7/16" notches in each end, as shown. Drill ⅛" holes 5/32" deep at the centers of both pairs of dowels to receive short ⅛" dowel spacers, which also act as braces.

Both end walls or handles are of 7/16" clear pine, 3" by 13". Cut the top curve and the curved slot for the handle, round the ends, and drill the ½" holes 3/16" deep, as shown. Blind grooves 1/16" wide and spaced ⅝" from the bottom are cut between the ½" holes. Note that these holes are located ⅝" in from the rounded ends.

Fasten the edges of the woven-wood mat into the cuts in the ½" dowels, keeping the long strips and dowels in line. Clinch the joints with ¼" brads from underneath. Next, fasten the handles to the ends of the mat and to the dowels, using glue on the dowels. Clinch from underneath with brass-headed upholsterer's tacks, which will also serve as casters. Attach the 5/16" top rails to the sides, inserting the ⅛" spacer braces in the ⅛" lined-up holes of top and bottom dowels. Use ¾" escutcheon pins in predrilled holes at the ends of the rails; these extend down in the bottom dowels.

Sandpaper all inside and outside curves and dull the edges of the woven wood. Give two coats of clear lacquer, rubbed between coats, and wax several times. If you prefer, you can, of course, use colored enamel for a gay modern finish. Either a single color, two harmonizing hues, or two tones of the same color might be used. Working time: 5 hours.



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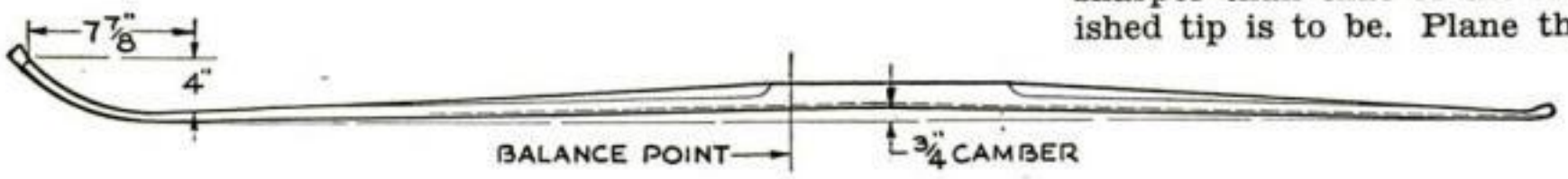
Laminated Tips Simplify Ski Making

By
R. H. JENKINS
Professor of Industrial Education,
Humboldt State College, Arcata, Calif.

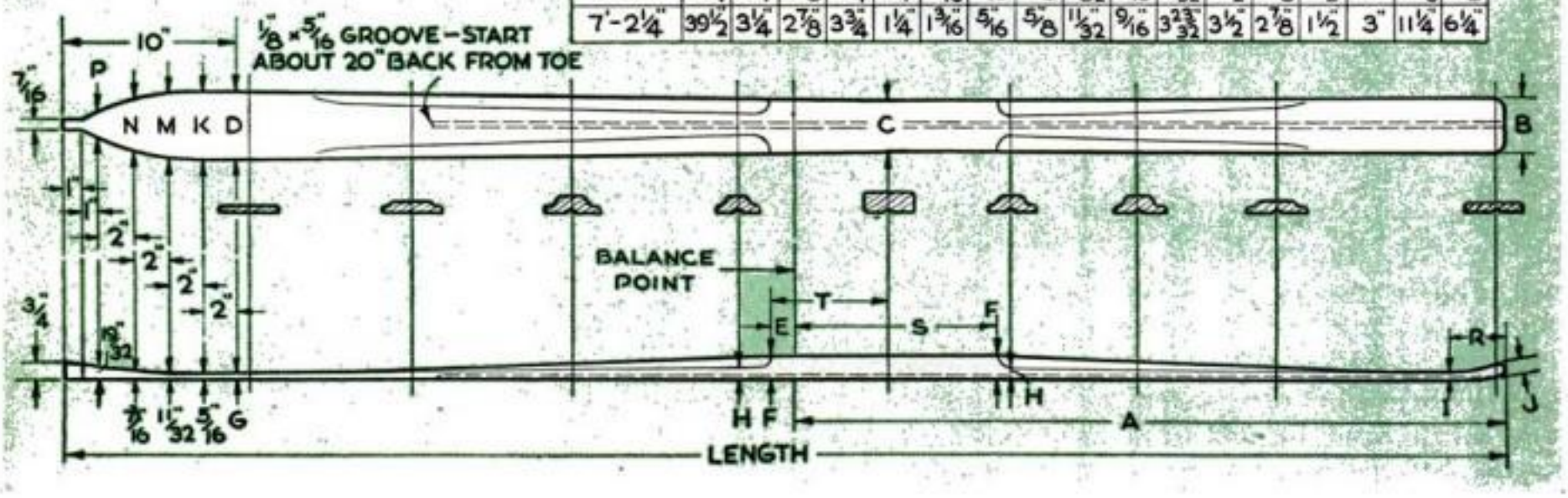
MANY who have wished to make their own skis have hesitated because of the difficulty of bending solid tips. However, very satisfactory skis can be made by laminating the tips, and no boiling or heating is necessary with this type of construction. The bend so formed is more permanent than one made in solid stock, and the tip is less likely to break. Furthermore, handsome two-tone effects and overlays can be produced by the use of woods of different colors.

Saw a clamping jig from 6" stock as shown in the drawing on the facing page, making the curve just a trifle sharper than that of the finished tip is to be. Plane the



This chart and the drawing below give all critical dimensions for standard ridge-top skis, which can be made with solid or laminated tips. Above, tip and camber bent

	DIMENSIONS FOR RIDGE-TOP SKIS																
LENGTH	A	B	C	D	E	F	G	H	I	J	K	M	N	P	R	S	T
5'-11"	32½"	3⅛"	2⅞"	3½"	2¼"	1 1/16"	¼"	7/16"	5/16"	9/16"	3 15/32"	3¼"	2⅞"	1½"	3"	9"	5½"
6'-4¼"	36"	3 3/16"	2⅞"	3 9/16"	2"	1 1/16"	¼"	½"	5/16"	9/16"	3 19/32"	3 5/16"	2⅞"	1½"	3"	10"	5¾"
6'-8¼"	36¾"	3 3/16"	2⅞"	3¾"	1¾"	1⅛"	9/32"	9/16"	5/16"	9/16"	3 23/32"	3½"	2⅞"	1½"	3"	10⅛"	6"
6'-11¼"	38½"	3¼"	2⅞"	3¾"	1¼"	1 3/16"	5/16"	5/8"	11/32"	9/16"	3 23/32"	3½"	2⅞"	1½"	3"	10¾"	6"
7'-0"	38¾"	3¼"	2⅞"	3¾"	1¼"	1 3/16"	5/16"	5/8"	11/32"	9/16"	3 23/32"	3½"	2⅞"	1½"	3"	10⅞"	6⅛"
7'-2¼"	39½"	3¼"	2⅞"	3¾"	1¼"	1 3/16"	5/16"	5/8"	11/32"	9/16"	3 23/32"	3½"	2⅞"	1½"	3"	11¼"	6¼"



HW 482

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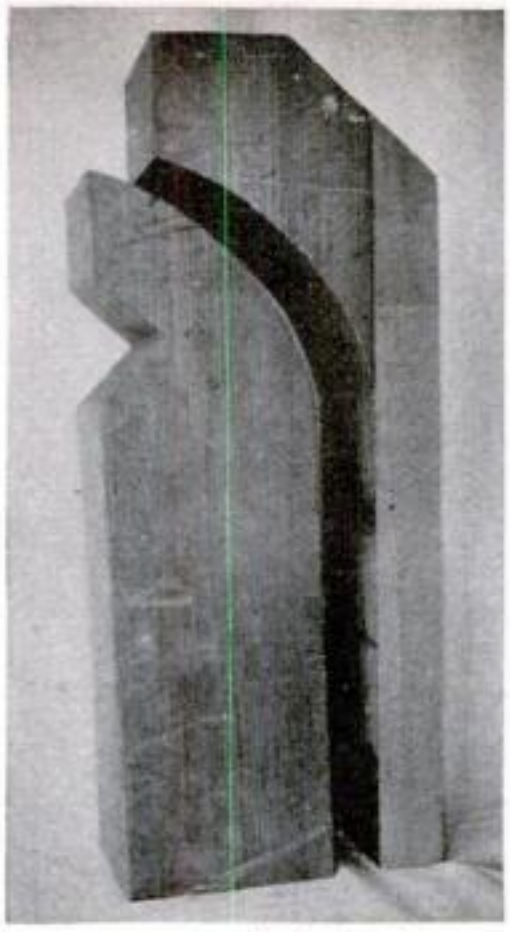
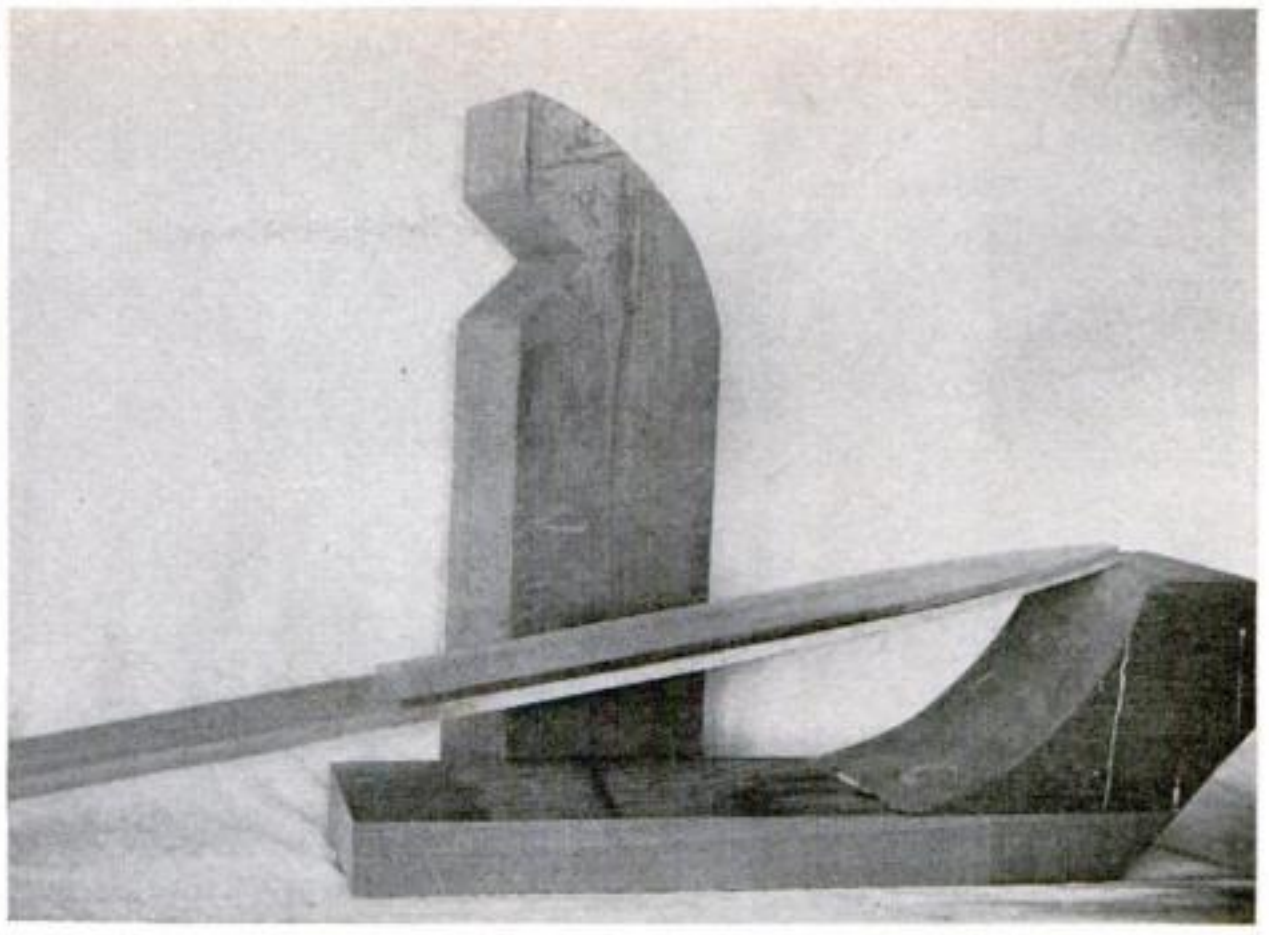


Saw jig to a slightly sharper curve than tip is to have



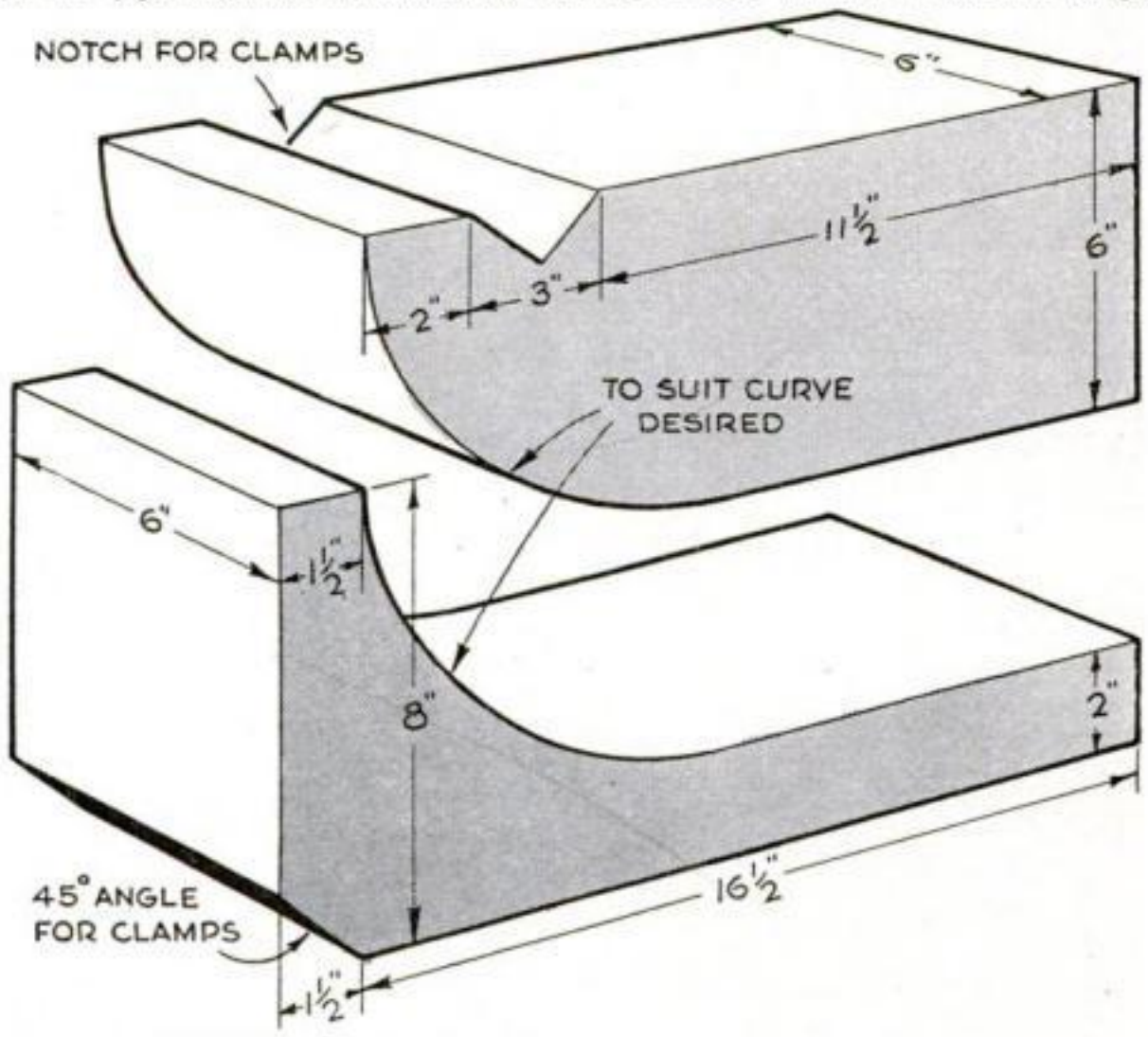
Ski billet and lamination of contrasting wood glued together and ready for the jig. Narrower laminations can be added later to form the ridge

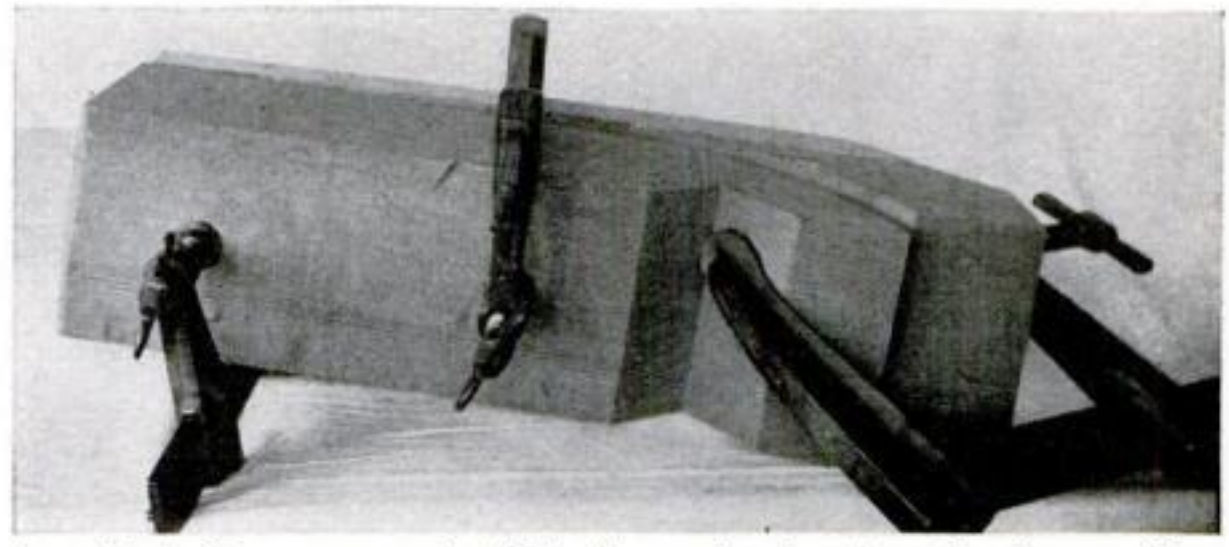
end of the ski billet so that it is only 3/16" or ¼" thick. Cut the laminations from 3/16" stock. Mahogany and hickory are a good choice to use together for two-tone tips.

Apply waterproof casein or resin glue to the top of the ski blank as well as to one surface of the first lamination. Clamp these parts together in the jig, applying pressure slowly and evenly. Do not remove the parts from the jig or loosen the clamps until the glue has had plenty of time to dry thoroughly throughout the joint.

Further laminations are added in the same way. Even the ridge top can be made of inlaid stock when this method is used.

For two-color effects, the woods used should, of course, be alternated. Be sure to make the tip of the ski as smooth as possible to minimize the likelihood of its catching on ice or clothing, and to lessen the danger of personal injury in case of accident.





A notch in the upper part of the jig, and a bevel on the lower, allow a clamp to be placed across the front. Three clamps hold all securely

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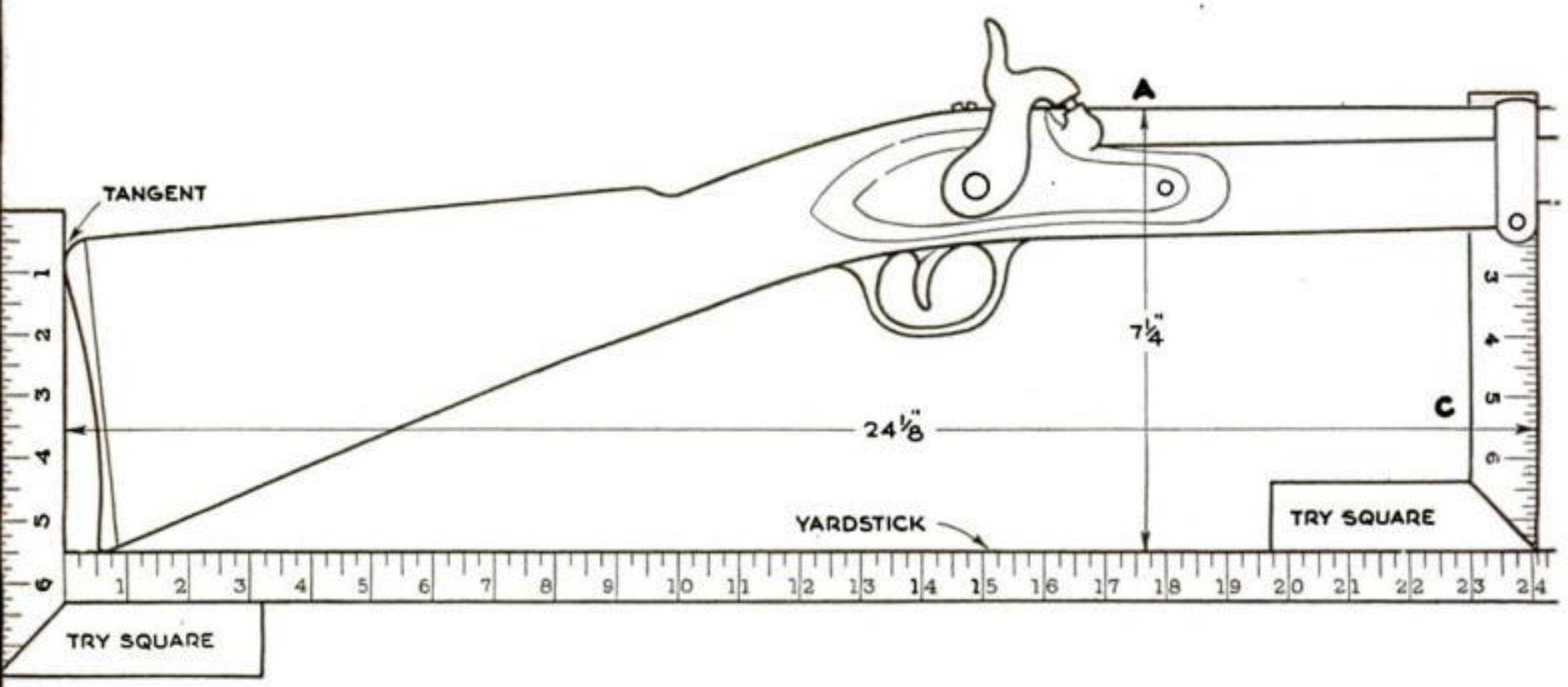
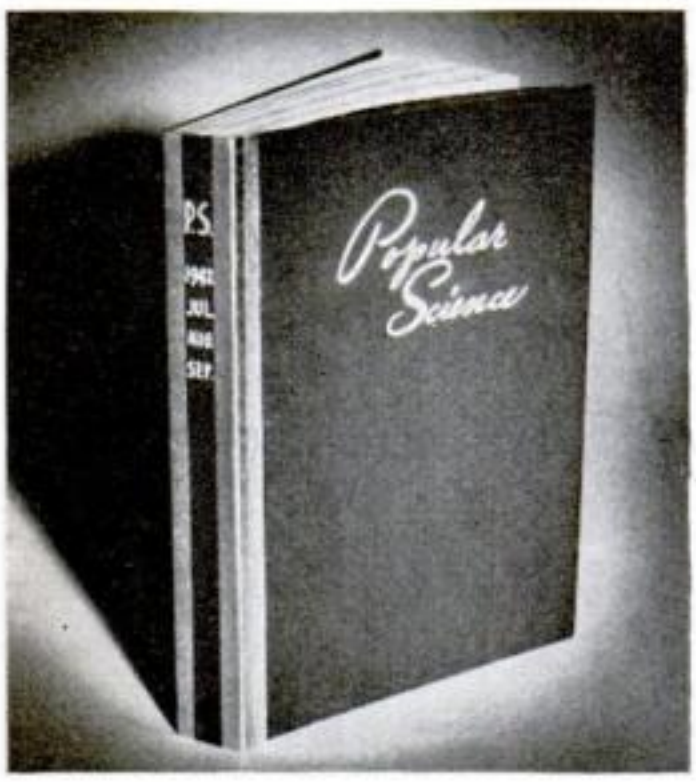
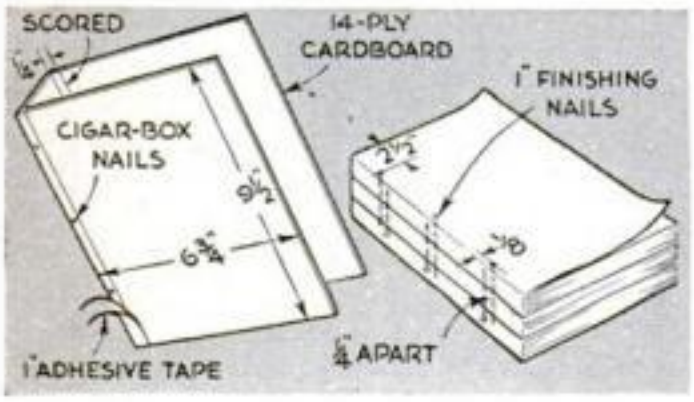
How to

Carl G. Erich's articles on whittling gun and pistol models have aroused much interest in this hobby. Some readers who have made the firearms he described have expressed a wish to model old guns of their own, but are puzzled by the problem of taking off measurements accurately. Here Mr. Erich explains how he does this







HW 484

Finishing Nails Used to Bind Magazines into Neat, Serviceable Volumes

ATTRACTIVE, durably bound volumes, each containing three issues of POPULAR SCIENCE, may be made simply by nailing them together with 1" finishing nails. This method requires no press and is much easier than the conventional one, yet gives surprisingly neat results provided you are very careful to keep the magazines aligned. The bound volume opens well and remains flat when closed.

First, the magazines are carefully stacked and nailed together with six 1" finishing nails, three from each side. These are placed as shown in the drawing; each goes through two magazines and about halfway into the third one. Then the cover is cut from a piece of heavy cardboard. Any available cardboard may be used, but 14-ply showcard stock was found quite suitable by the writer. The cardboard is cut halfway through where it is to be bent. All dimensions are given in the diagram, except the thickness of the magazines, which must be measured after they have been nailed together. Cigar-box nails are used to attach the cover, and strips of 1" wide paper adhesive tape are pasted over the nailheads and score marks. The nails will not be visible inside or outside the book, and anyone who is not aware of the method will be mystified as to how the book was bound.—FRANK SHORE.

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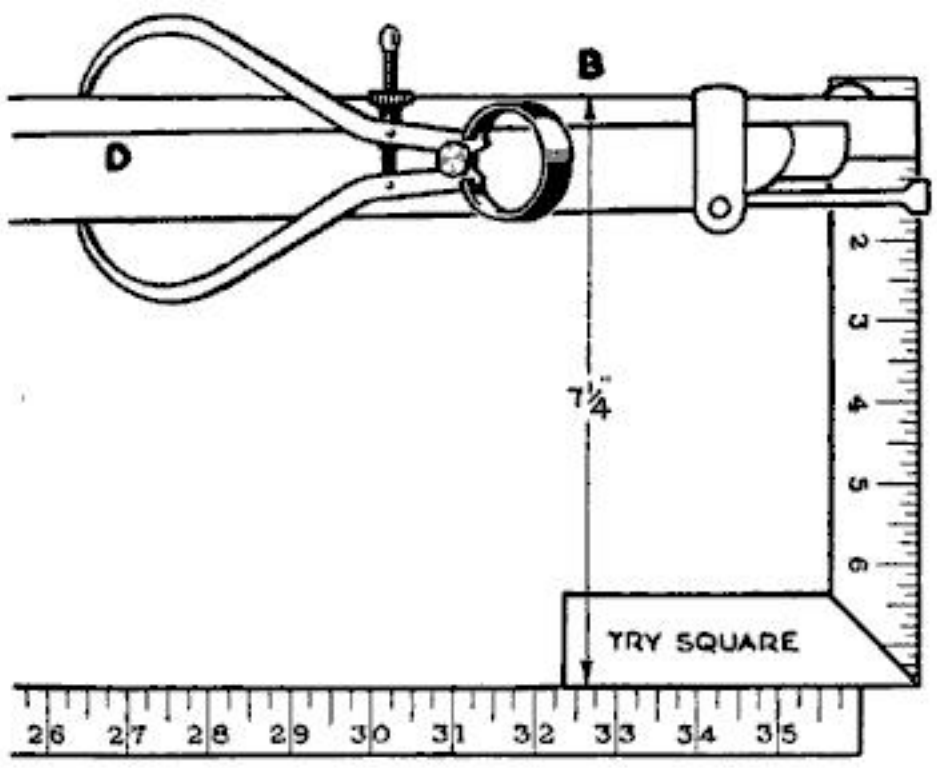
Measure a Gun Accurately

SIMPLE METHOD OF SCALING OFF DIMENSIONS FROM ANY FIREARM



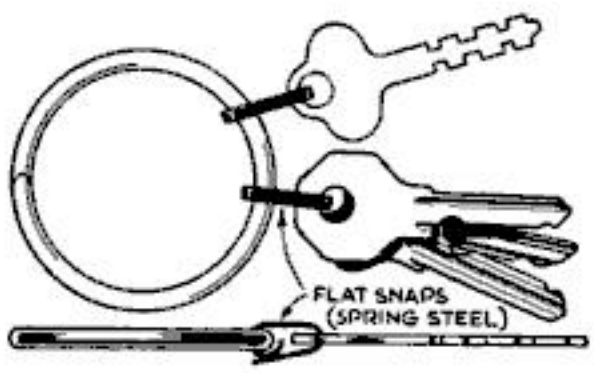
MEASURING a gun or pistol is a simple procedure. Once certain key points are fixed, a drawing can be made or a blank cut out for a whittled model. A yardstick, one or more try squares, and calipers are the only tools needed.

Clamp or otherwise fasten a yardstick to the bench or table. Lay the gun down with the butt against the yardstick and have the distance from the gun to the yardstick the same at *A* and *B*. With the gun and yardstick in this position, all measurements from the butt or the end of the barrel, such as at *C*, can be located accurately. Thicknesses and widths, as at *D*, are obtained with the calipers.

This method will give measurements for a full-scale model. For a half-size model, they should be divided by two and used in making a drawing from which the blank can be marked, or the layout can be drawn directly on the wood from which the whittled model is to be made, the same scale being maintained.—CARL G. ERICH.

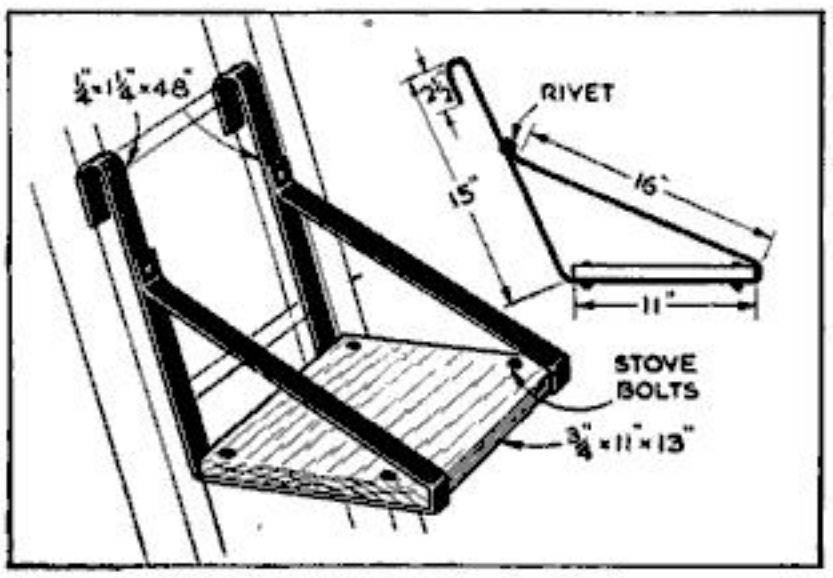
Flat Steel Snaps on Ring Permit Keeping Keys in Groups

ANY key ring can be fitted with flat key snaps bent from spring steel as shown at the right. These will allow even a good-sized bunch of keys to lie flat in the pocket. Furthermore, a group of two or three keys, such as automobile ignition, tank, and trunk keys, can be taken off the ring together and as easily replaced when no longer needed.—R. L. WHITMAN.



Platform Hooked on Ladder Rung Provides Secure Footing

A HANDY ladder platform may be made from two pieces of band iron, each ¼" by 1¼" by 48", and a short board. Such a platform is safer and much more comfortable to stand on than ladder rungs, and is especially valuable when installing eaves troughs and the like, since it brings one alongside his work rather than underneath it. The band iron specified is probably too thick to be bent without heating, but a blowtorch will do the trick, or, if you have no facilities for such work, you can have the metal shaped by the local blacksmith. Bend the upper ends to hook well around the rung.—ALLEN G. BROWN.



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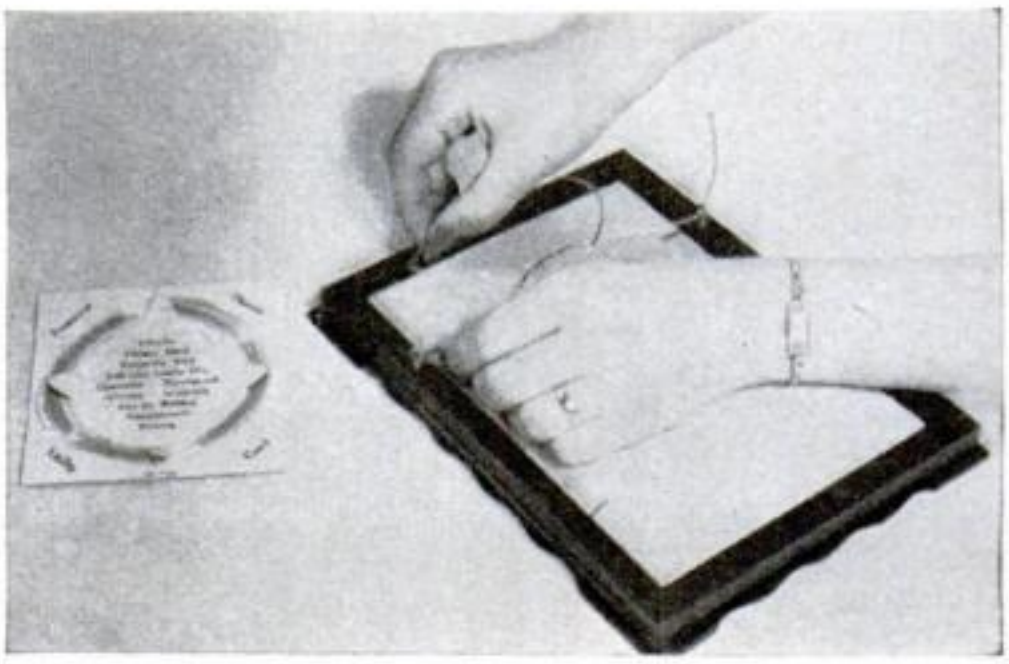
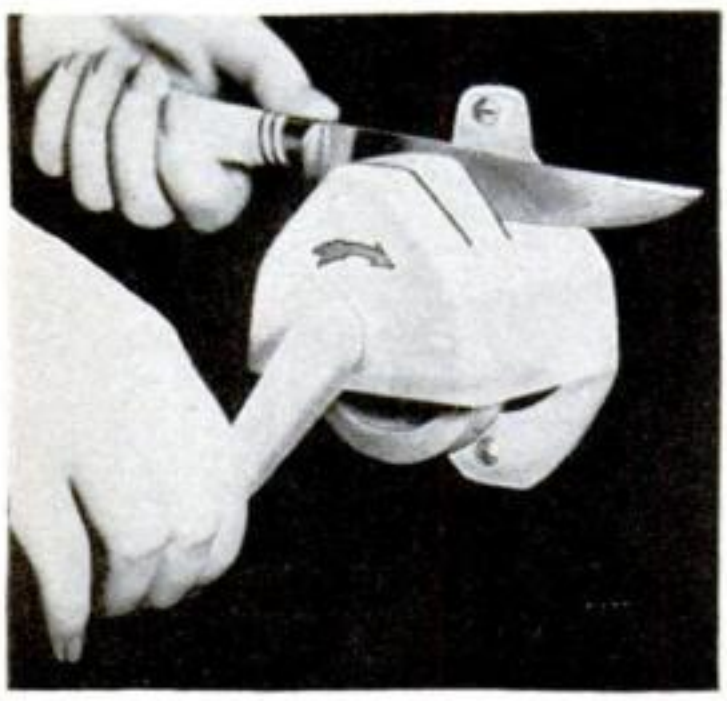
NEW APPLIANCES to aid in

GLASS COFFEE MAKERS now on the market will be of interest to housewives who cannot replace old metal coffee brewers. The model illustrated at the left, one of several types now being made, works on the extractor principle. For those who prefer the other traditional methods of brewing coffee, percolators, drip, and vacuum brewers are made

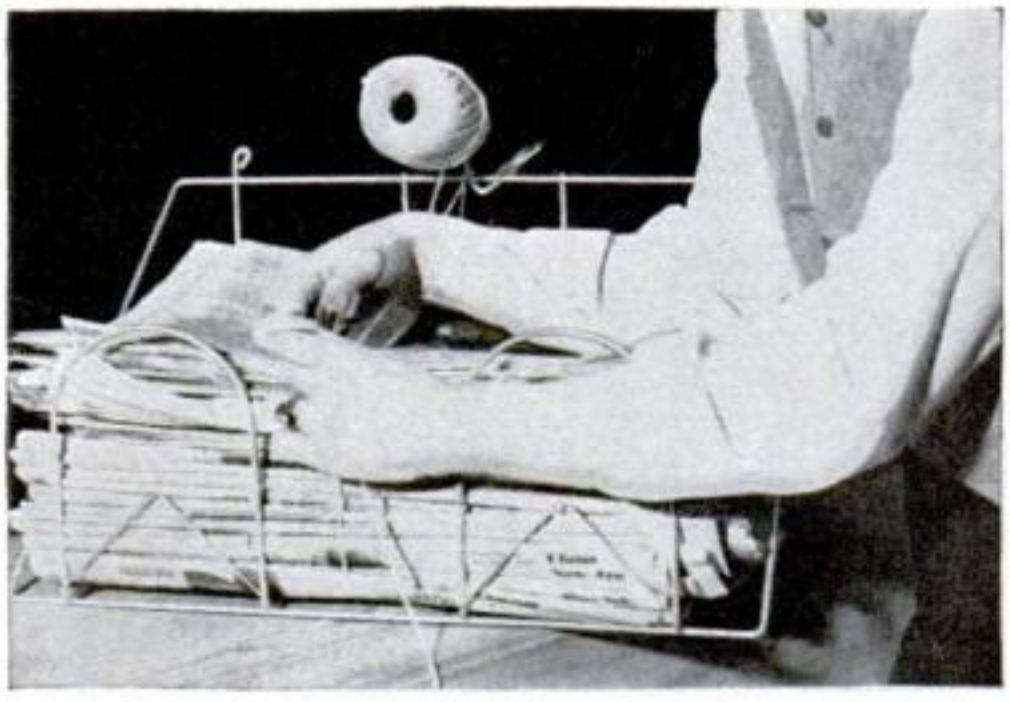


PLASTIC PICTURE CORD has been introduced as a non-metallic product to take the place of orthodox steel picture wire. Of great tensile strength and readily cleaned, this new cord will serve as leaders for fishing lines and for general mending wherever steel wire is usually needed

A CARPET-CLEANING POWDER (left) is being made which dispenses with water and allows the carpet to remain where it is. The powder is simply sprinkled on the rug, brushed in, and removed in about one hour with a vacuum cleaner. After treatment a soiled rug turns several shades lighter



THIS NEW KNIFE SHARPENER, equipped with a high-grade bronze-bearing and self-lubricating hone, is designed so that the guide slots automatically hold the knife blade at the correct angle for sharpening. Available in ivory, white, red, and green enamel finish, it is handy in the kitchen



A PAPER BALER for use in conserving waste paper and magazines may prove a great help to the busy housewife who has no handy corner or cellar space for storage. The model shown above comes with a spool for string or cord, and has a guarded holder for a single razor blade or other cutting instrument. This paper baler, designed to hold 25 pounds, is said to be approved by many salvage directors

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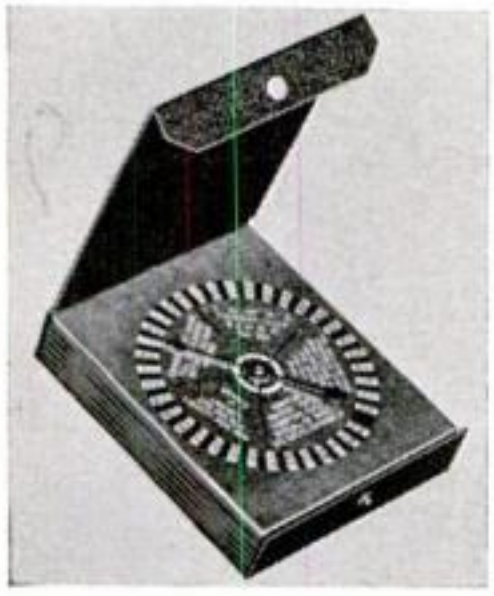
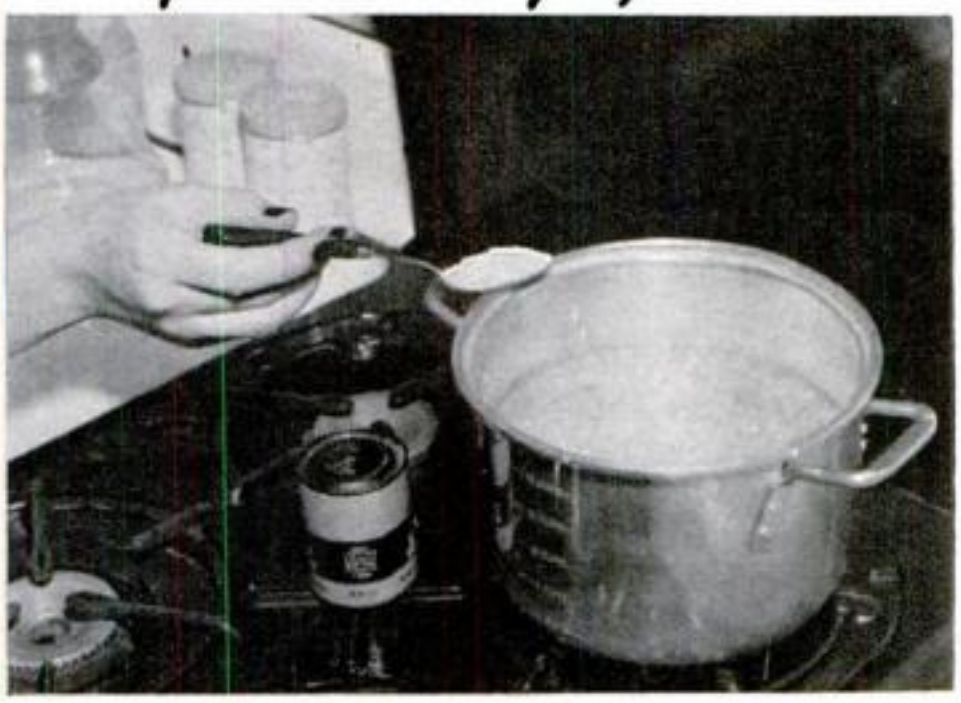
Housekeeping

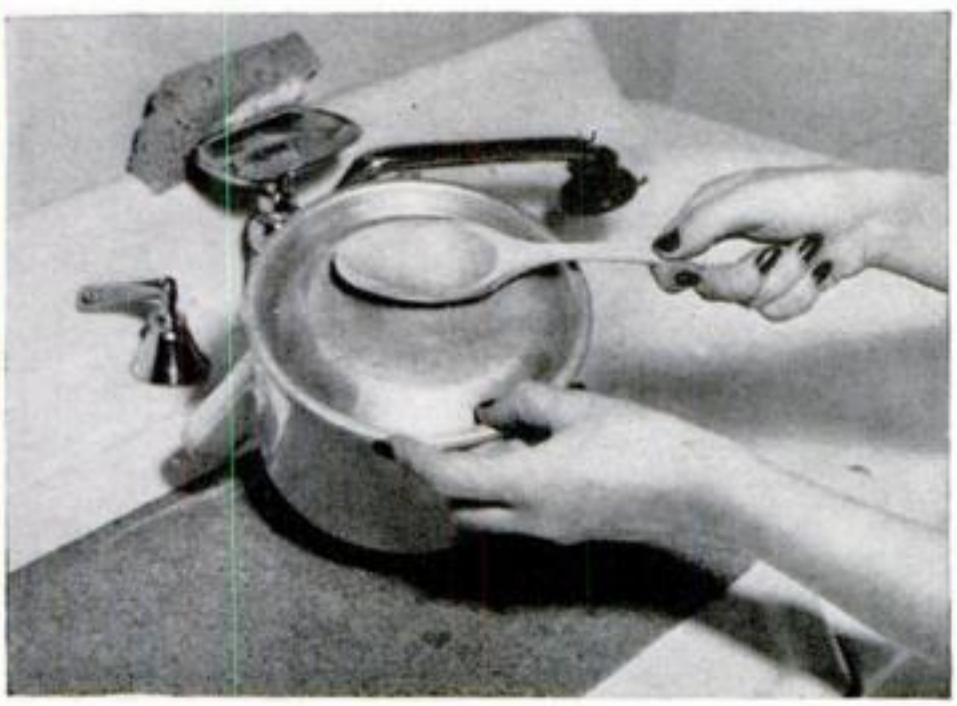


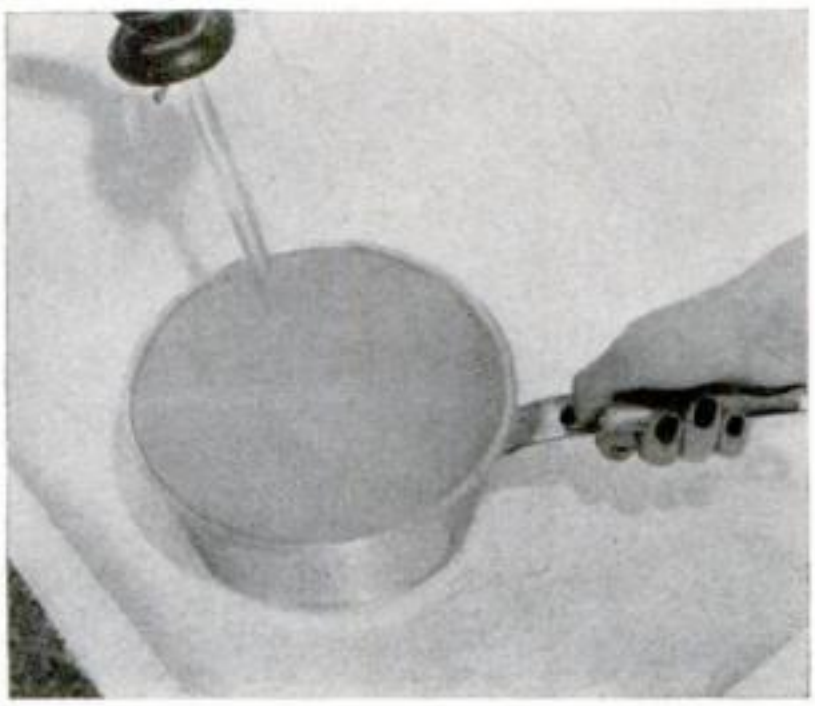
THE LIBRARY OF GAMES from which the above samples were taken contains 18 "volumes" in all, including many of the games of chance and skill that most adults enjoy. Designed on a pocket-size scale to look much like books, the games are ideal for travelers or men in the armed services. The binding is in simulated morocco

Tips on Using Your Aluminum Kitchen Utensils



DISCOLORATION on the inside of pots and pans can be removed by boiling a solution of cream of tartar (left) in the utensil for a few minutes. The brightness of the metal is restored by polishing with a very fine steel-wool scouring pad. If the inside of your teakettle is coated with lime deposits, heat the kettle gently without water, then tap the bottom lightly with a wooden mallet or spoon until the coating is loosened (below, left). Avoid too-rapid temperature changes, as filling a very hot pan with cold water (below).





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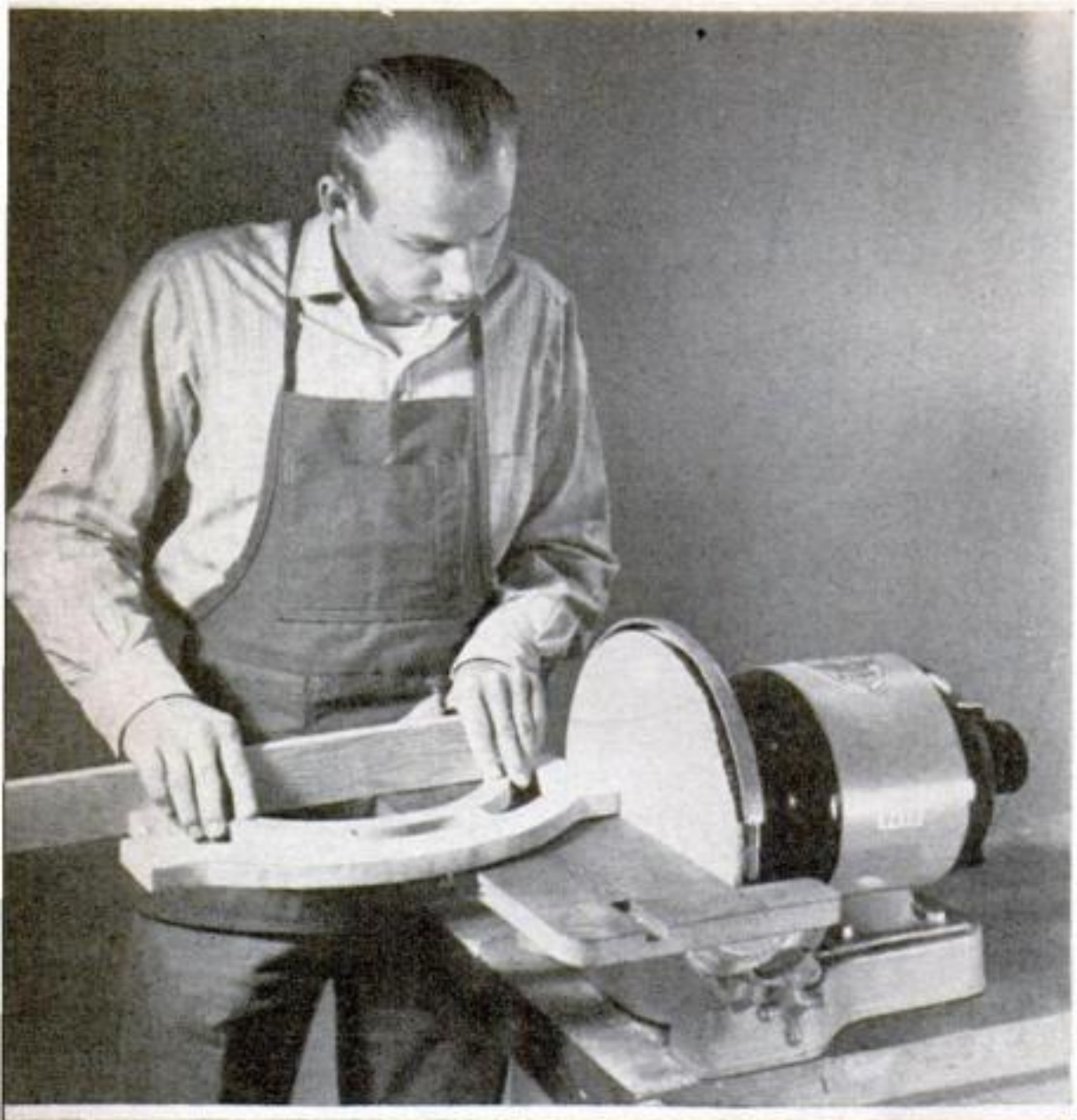

Sanding isn't the only job you can do on power sanders, which are among the most versatile tools in the shop. Here an auxiliary fence is attached to the miter gauge to aid in squaring an end

Power Sanders
SPEED WOODWORKING CHORES

By EDWIN M. LOVE

IT IS said that it costs $75 in hand labor to use up 75 cents worth of sandpaper. Sanding is certainly an irksome task, for it is hard, time-consuming work, and much of it must be done just when a piece of furniture is nearly ready for finishing. Bench sanding machines bring a satisfying release from this drudgery. Moreover, they are not only tools for smoothing, but also cutting machines that can be used for much of the preliminary shaping.

What types of bench sanders are available? There are two main kinds: sanding disks and sanding belts. In the first a metal disk is faced with abrasive cloth or paper; in the second the abrasive surface takes the form of a belt running over two drums.

How are sanding machines made ready for use? The table should be set close to the disk or belt so that thin materials can be held on edge against it without slipping between the abrasive surface and the table. Check the groove of the latter for parallelism, preferably by measuring to the metal disk or backing before the abrasive material is put on. Locate the square or zero position of the tilting table by checking trial cuts with a square. Set the pointer on the quadrant scale accordingly.

Which abrasives are commonly used? In woodworking, garnet paper is generally employed for disks, and garnet paper or cloth for belt sanders. For metal and plastics, various grades of silicon carbide, aluminum oxide, and emery cloths can be used.

There is no economy in using ordinary

Fig. 1
APPLYING STICK ADHESIVE TO DISK

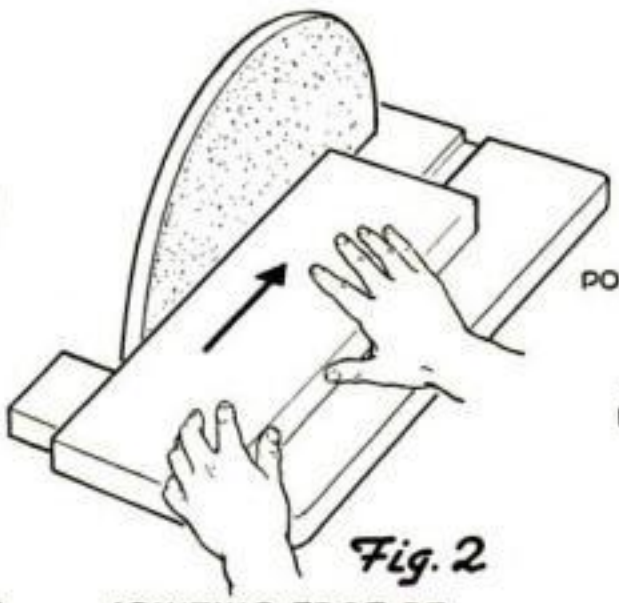

Fig. 2
JOINTING EDGE OF SHORT BOARD

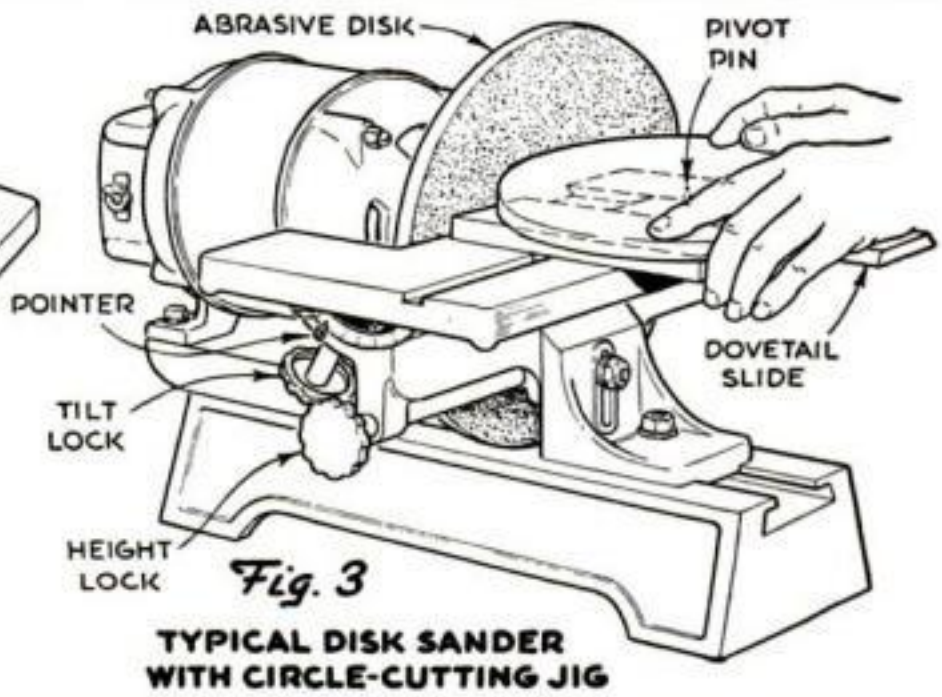

Fig. 3
TYPICAL DISK SANDER WITH CIRCLE-CUTTING JIG

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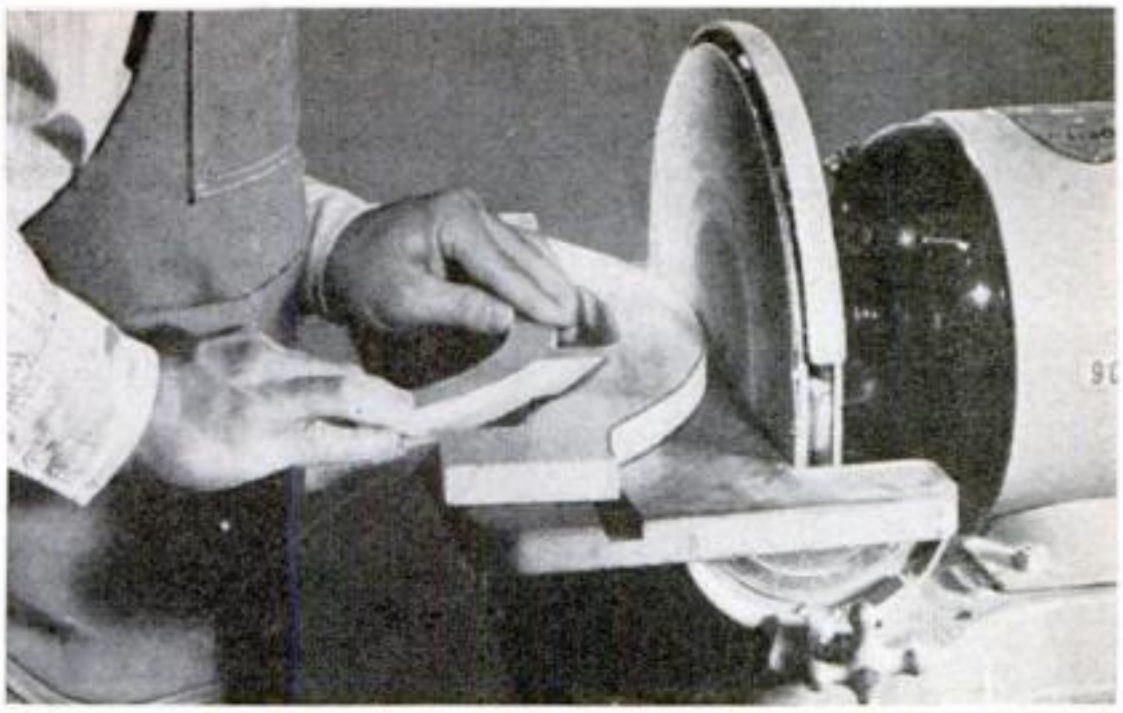
Convex curves are shaped quickly and accurately. Work against the downward-turning side of the disk whenever possible, so that stock will not tend to lift off the table



sandpaper on a disk sander, although it will serve in an emergency. No. 1½ garnet paper is fast-cutting and suitable for roughing, while No. ½ is right for most wood finishing. In production work, it is well to have two sanding disks on hand, one for roughing and one for finishing.

How is abrasive paper fastened to a disk? It can be attached with various adhesives, but a stick variety incased in pasteboard and resembling belt dressing is especially convenient in the home workshop. It is held against the rotating disk as in Fig. 1; then the garnet paper is pressed on. It is immediately ready for use. Old sandpaper is easily stripped off if this adhesive is used.

At what speed should a disk turn? Many 12″ disks are mounted directly on 1,750-r.p.m. motors. The limiting factor is the tendency of high speeds to burn the wood and glaze the abrasive. For metal cutting on belt-driven machines, the speed can be increased by changing pulleys.

What is a typical disk-sanding operation? Perhaps the most common job is shaping convex stock. Rough-cut the

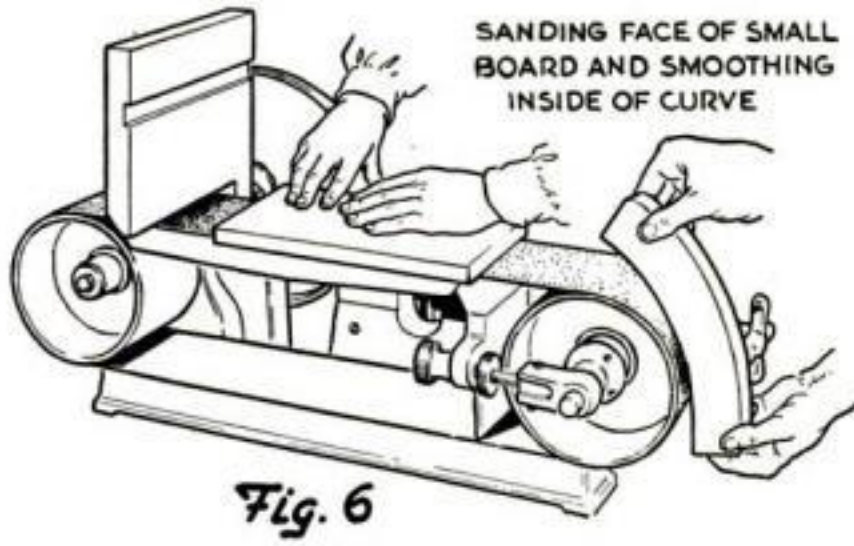


Fig. 6

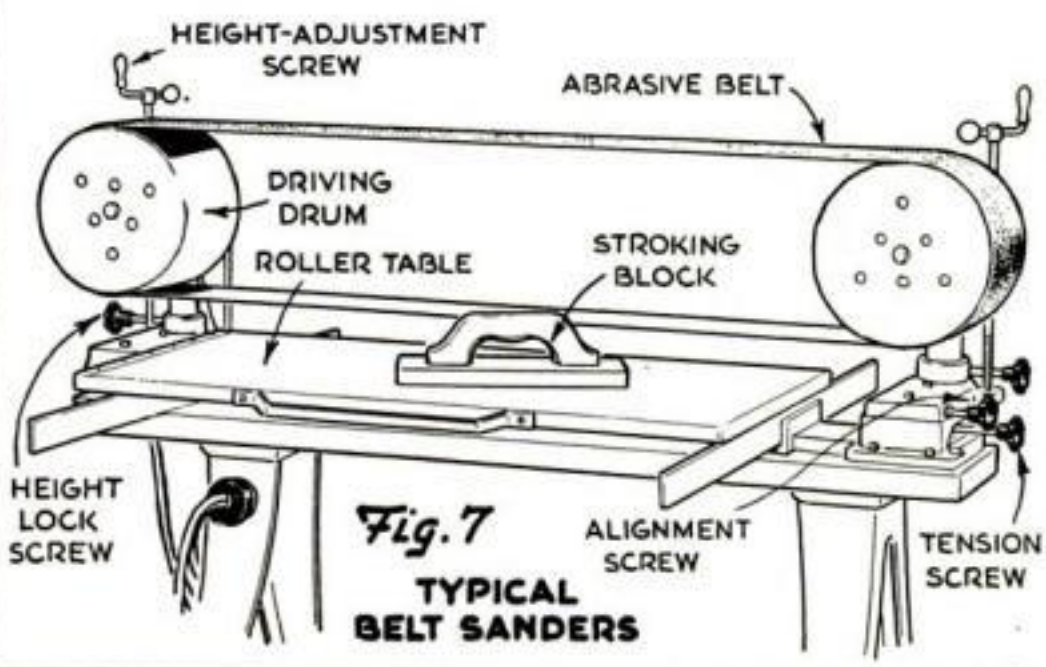


Fig. 7 TYPICAL BELT SANDERS

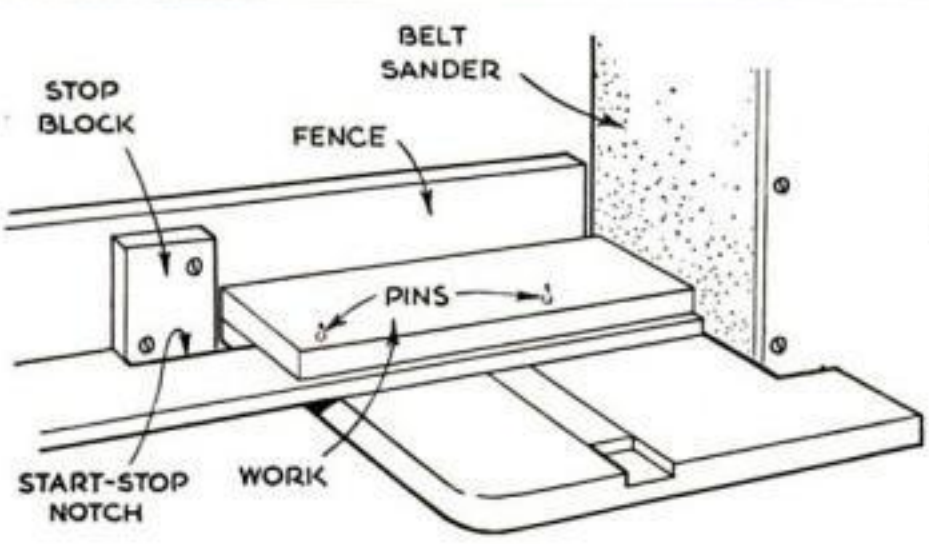
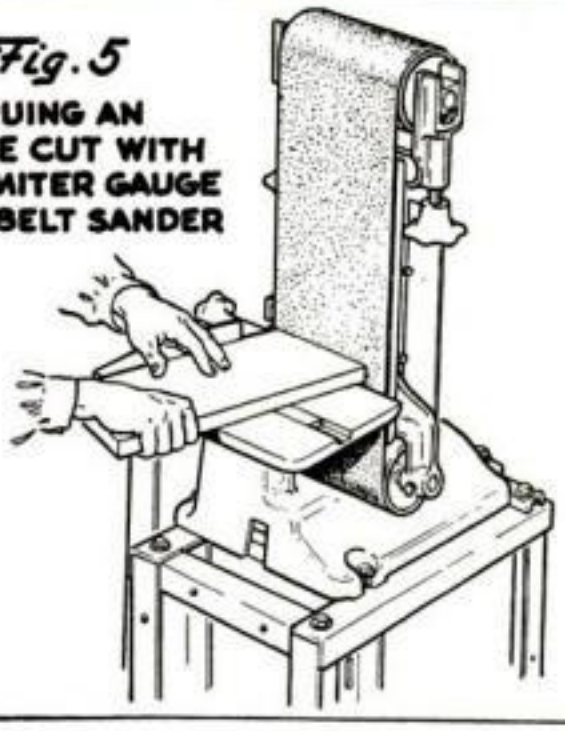


Fig. 4 JIG FOR SANDING PIECES TO EXACT LENGTH IN DUPLICATING

Fig. 5 TRUING AN ANGLE CUT WITH THE MITER GAUGE ON A BELT SANDER



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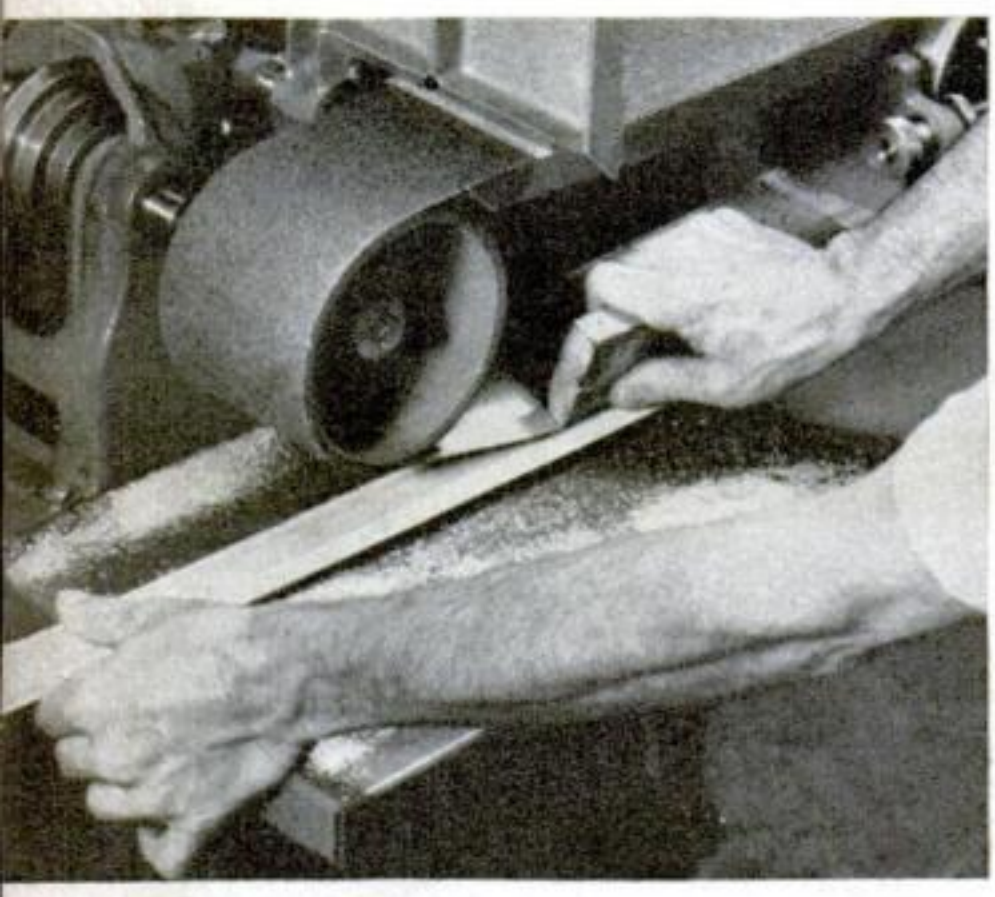
Above, the table tilted for sanding a chamfer on a shaped convex edge. Note the penciled chamfer line



Smoothing a molding against the lower half of a sanding belt. A shaped stroking block is employed

work; then feed it against the disk, as shown in a photo on the preceding page. Press lightly to avoid cutting past the line, and to lessen clogging of the paper. Don't let one part of the disk do all the cutting. Slide the work along the table to prevent scoring. As a rule, hollow curves should not be worked, although they can be sanded roughly to shape at the edge of the disk.

Edges of short work can be jointed by sliding it against the disk, as in Fig. 2, and joints can be trued to a line in the same way. The sanding disk is especially useful for shaping small pieces, squaring them, rounding corners, chamfering, and so forth. One of the photographs, for example, shows a piece previously sanded to shape being chamfered to a second line back of the first.

A pivot jig for sanding circles is suggested in Fig. 3. The dovetail is one half the depth of the auxiliary table, which has fastened to its underside a piece that slides in the table slot.

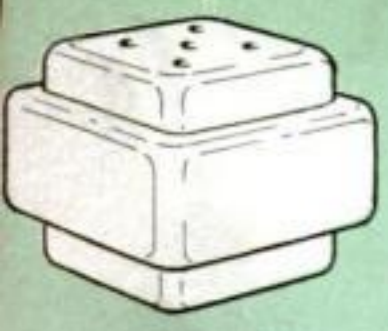
Since the outside of the disk travels faster than the inside, it cuts faster, and allowance should be made for this. The disk is not well adapted to surfacing large pieces.

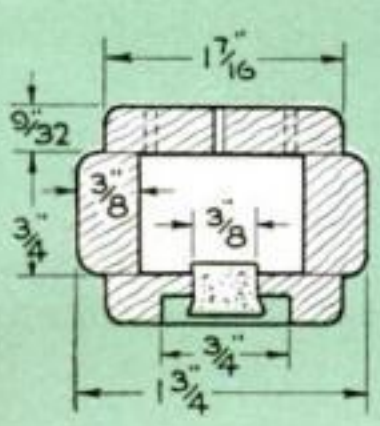
For what can the miter gauge be used? A piece is squared on the end by holding it against the gauge head, feeding it against the disk, and sliding the gauge. Clamping of the stock is therefore not practicable. A strip of wood screwed to the gauge head is helpful in many cases, as shown in the photograph on page HW 488.

A method of sanding to duplicate lengths is illustrated in Fig. 4. The notch in the baseboard slides against a stop block to limit the depth of cut. In use, the jig is slid out against the stop and the work is pressed down on the pins, with the outer end of it against the stop. The work is then slid along the fence as far as the notch will permit.

Angles, plain or compound, are as easily sanded as square ends. The miter gauge is simply set to the desired angle, and the table tilted if necessary.

Modernistic Salt Shakers Give Practice in Sanding





Each shaker is made of three parts, and glued together. The corners are sanded

THESE modernistic individual salt shakers give plenty of practice in sanding small pieces to size. Each shaker is built of three pieces, the middle one having a square hole scroll-sawed out of it.

Sand the parts to thickness and square them, afterward rounding the corners by rolling them against a sanding disk or belt. Bore the top holes and the filling hole, draw guide lines on the middle piece, and glue on the top and the bottom. Put toothpicks in the shaker holes and pour a little lacquer inside to waterproof the wood. Let the excess drain out; then immediately pull out the toothpicks. Stain, or finish in colors.—E. M. L.

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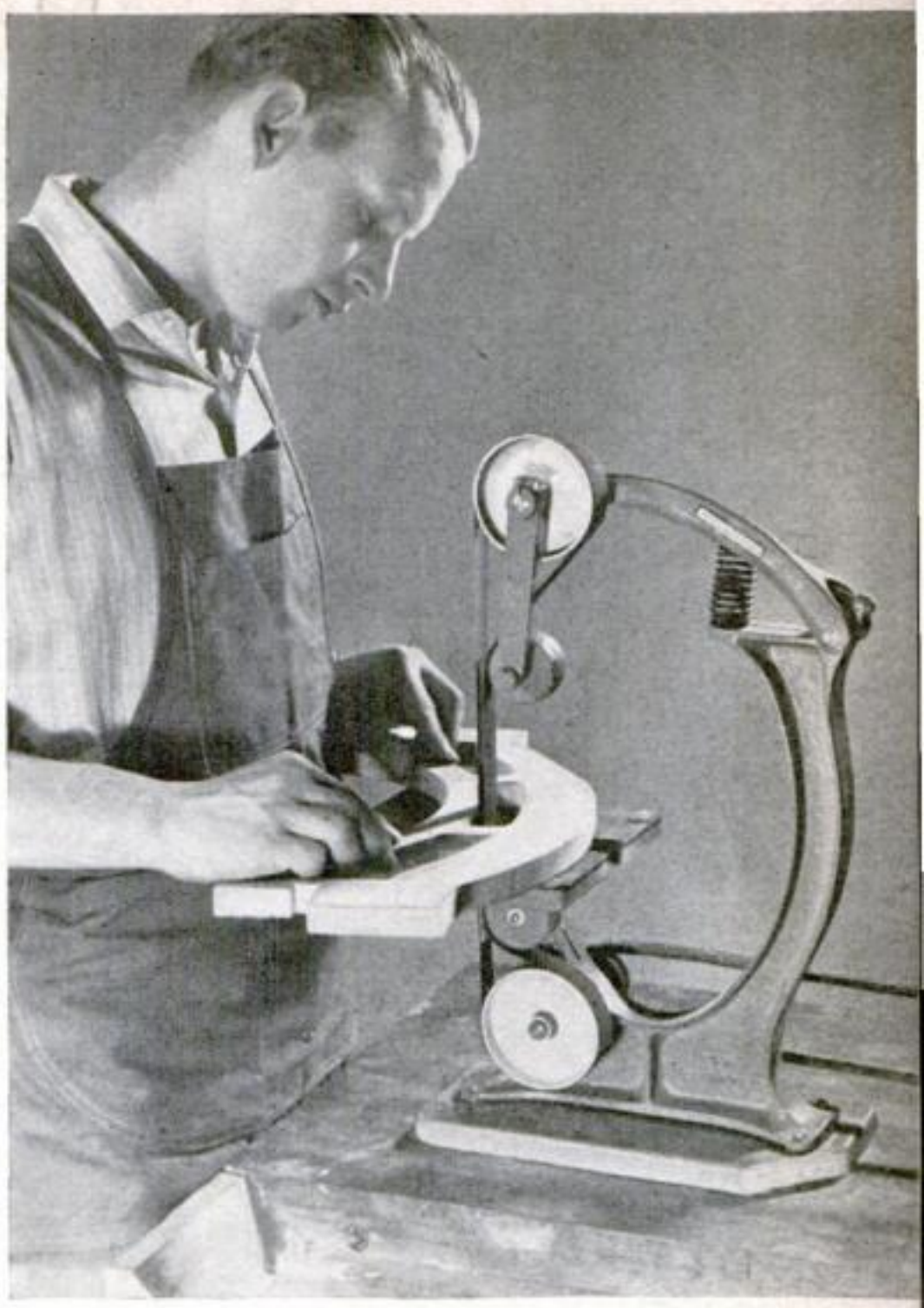
How is a belt sander used? See that the belt tracks properly and that the tension is set as specified by the manufacturer of the machine. All the operations described for the disk sander can be done on belt sanders with tilting tables (Fig. 5). Inside curves are smoothed on the drums, as in Fig. 6. Short boards are sanded by holding them on top, above the table, or on open models by laying them on the table beneath, lowering the belt, and stroking it against the work with a block, as shown in one of the photographs on the facing page.

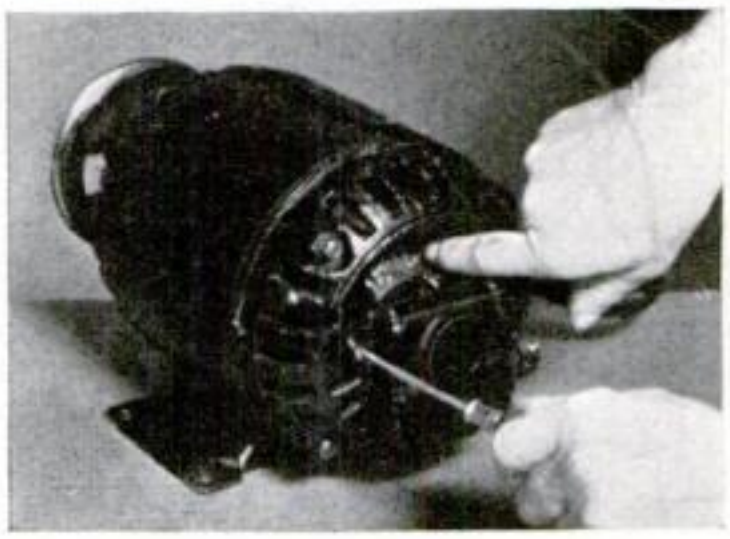
If the machine is equipped with a roller table (Fig. 7), long, wide boards can be rested on it, while the left hand moves the table crosswise. Several small pieces can be sanded at once on these tables. By slacking the belt a trifle and using curved blocks, hollow pieces and even moldings can be cleaned up. Some models permit an assembled cabinet or other piece to be set under them for sanding.

Are there belt sanders that will smooth cut-out work? A sander of this type is illustrated in the photograph on this page. For ordinary outside sanding, the belt goes around the two pulleys in the usual way, but for inside sanding it is passed through the work and in front of the idler pulleys, which hold the opposite sides close together. A slit less than ½" wide can be sanded with this setup. Flat and curved backing plates of various widths can be attached to the machine as needed, and belts can be torn into narrow strips for sanding in narrow openings. With suitable belts, intricate cut-out metal work can be finished.



Narrow-belt sanders are useful for smoothing inside cuts on scroll-saw work and the like. Idler pulleys hold the belt together for sanding small openings. Various backing plates can be attached

REPULSION-INDUCTION MOTORS [ELECTRICAL]



ALTERNATING-CURRENT motors having windings on both rotor and stator, and carbon brushes bearing against a commutator, are of the repulsion-start induction type. Such a motor is capable of starting machines under heavy loads, such as pumps and compressors. Its strong initial torque is due to the fact that it starts on a repulsion principle, with induced currents in the armature opposing those in the stator. When the armature attains full speed, centrifugal force operates a mechanism that lifts the brushes off the commutator, and the motor continues to run on the induction principle.

To reverse the rotation of a repulsion-start induction motor, it is necessary to loosen a setscrew holding the brush yoke, and push the latter around in either a clockwise or counterclockwise direction until a line or arrow on it coincides with a similar mark on the motor frame. The setscrew is then tightened.

POPULAR SCIENCE MONTHLY SHOP DATA

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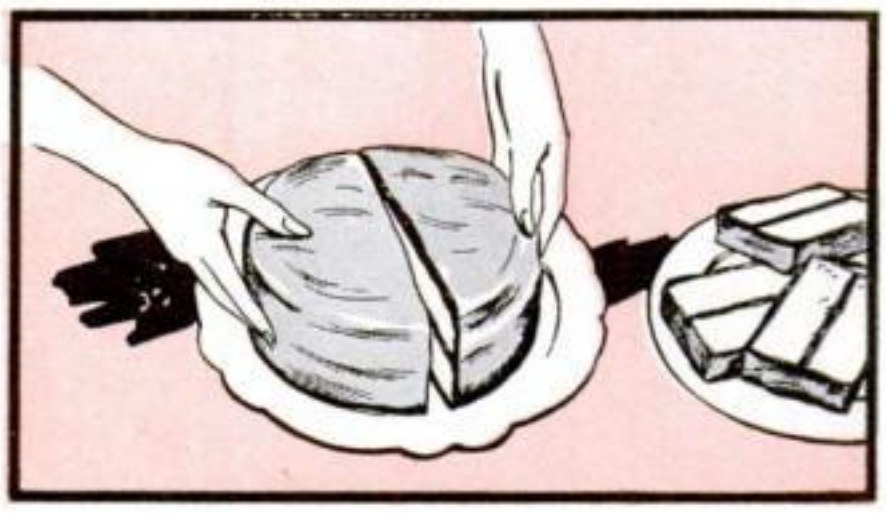
KEEPING THE

Dipped in soapy water, the bristles of an old paintbrush will get into corners of window panes and loosen dirt so that it may be washed away

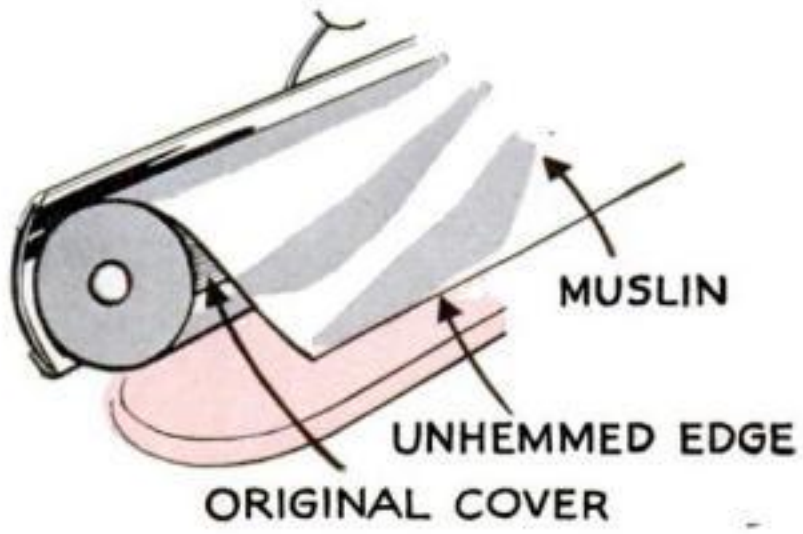


Cake can be kept from drying out by removing the first slices from the center, and pushing the two unused portions together to remain until needed

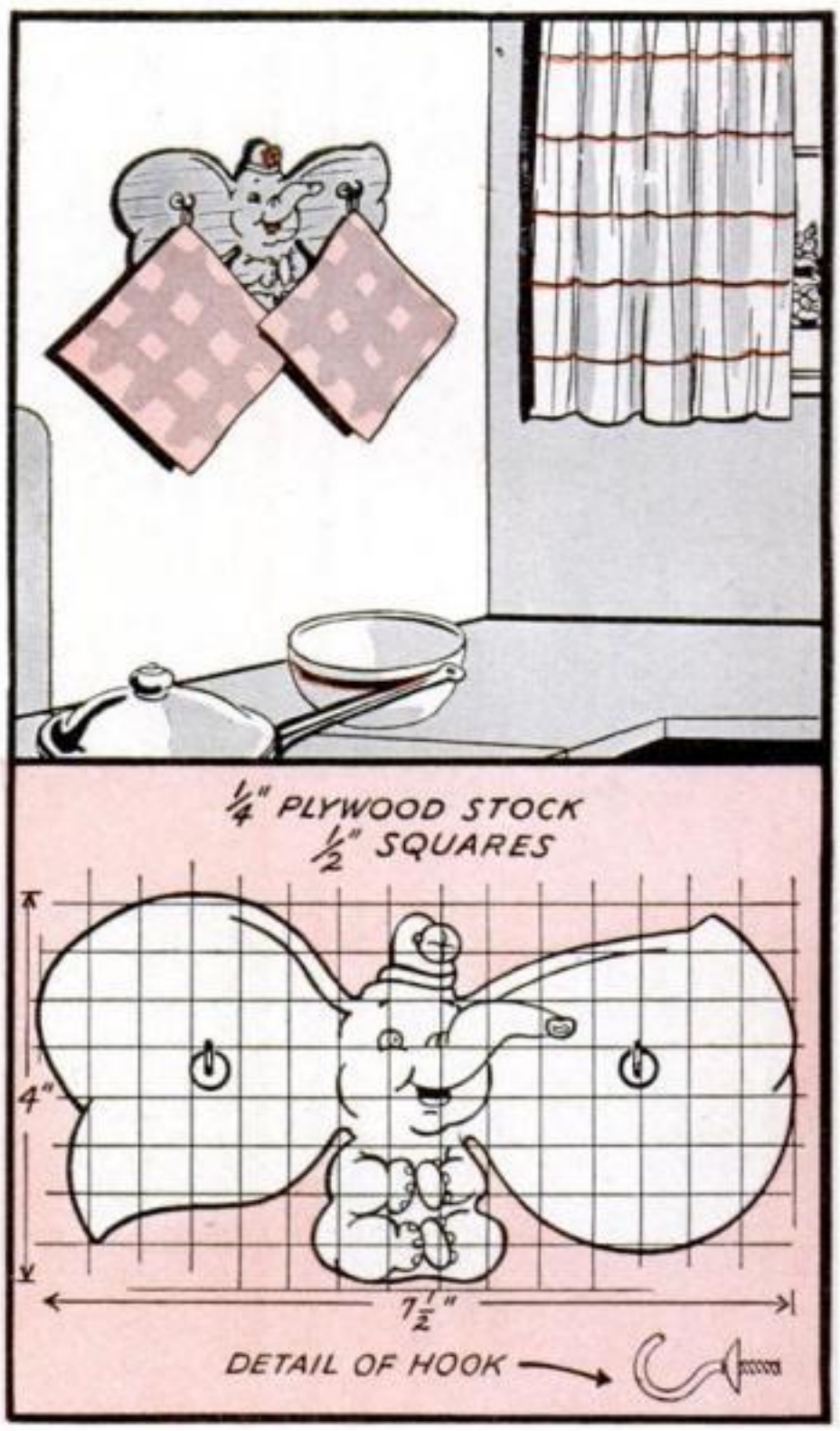
CRUMPLED WAXED PAPER

Waxed paper, used as a cushion filler, will wax needles and pins automatically as they are pushed in, thus retarding rust. Pack the paper in tight

Use steel wool to clean a clothesline in weather that freezes water. A pad will protect the hands



Unbleached muslin over an electric-ironer roll protects the original cover, and can be replaced when soiled or scorched. Overlap the ends by half the circumference, and leave them unhemmed. Basting or draw strings will secure the two sides



Here is a neat kitchen hanger for pot holders. Paint in the lines; color eyes, hat, mouth, and small details; and finish with shellac. File cup hooks flush at back. Drill a nail hole in the hat

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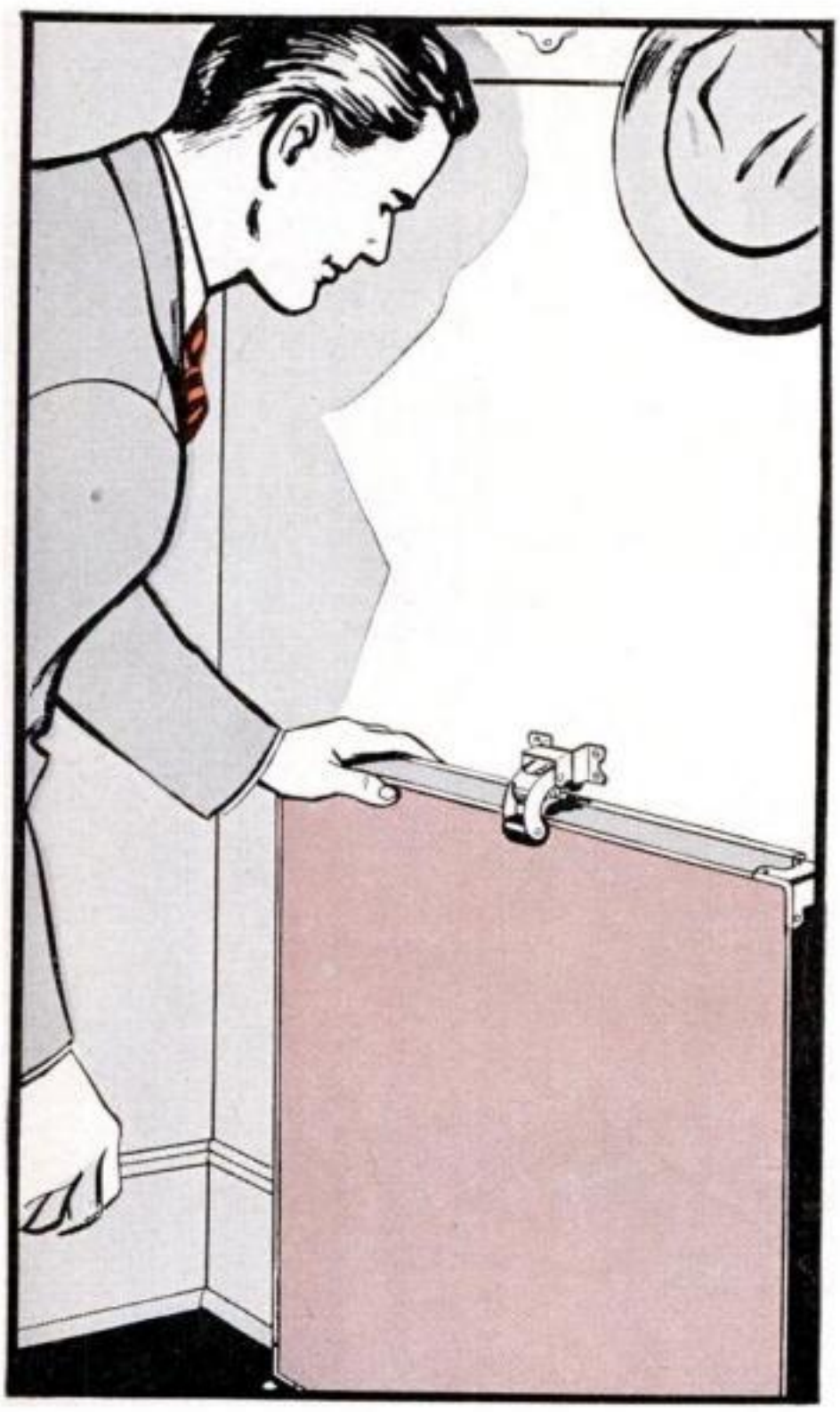
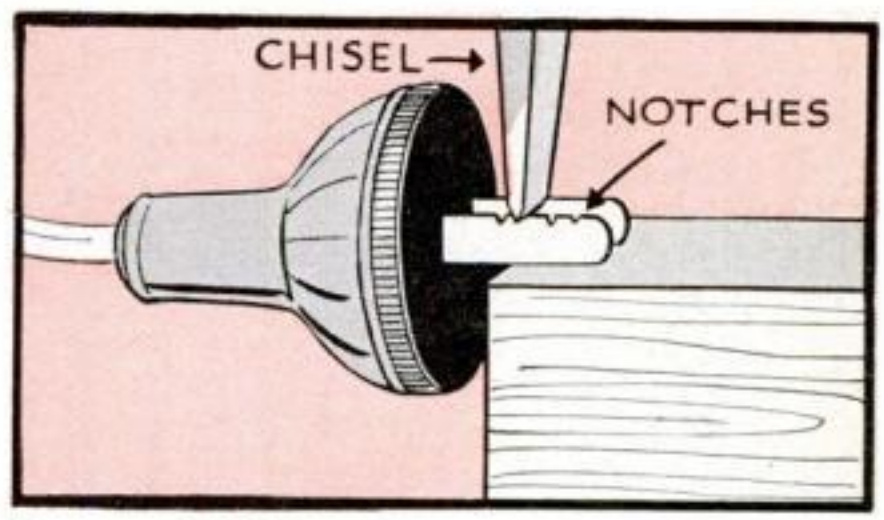
HOME SHIPSHAPE

Scrap pieces of carpet or rug padding are cut to size, sewn together, and covered with tough cloth to form a serviceable knee pad. Two or three thicknesses should be used. Similar pads will be found effective as insulation over an auto floor

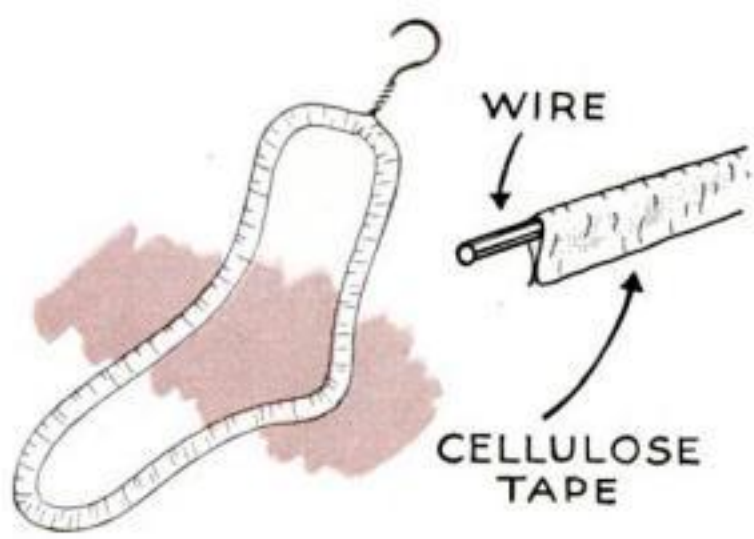
Temporary repairs to a cracked watch crystal may be made with cellulose tape. Trim to fit with a razor blade, taking care not to scratch the case



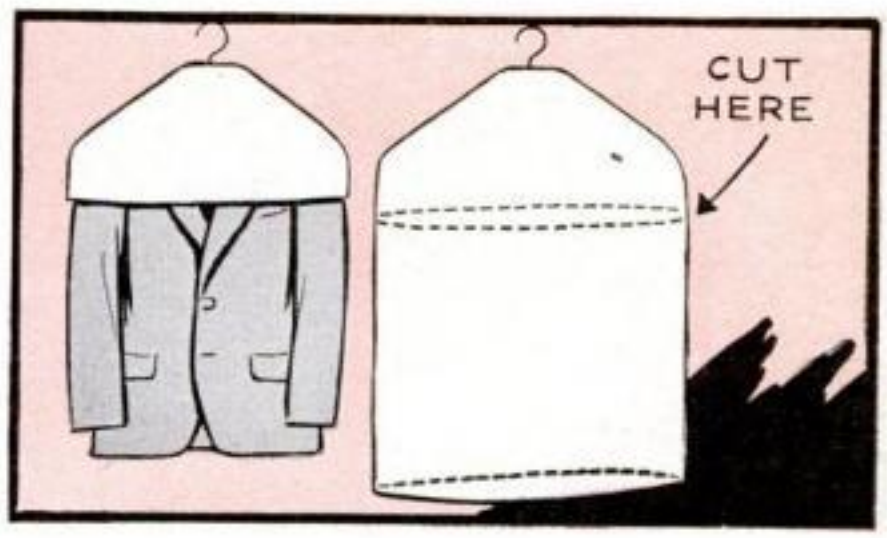
Attached to a closet wall at the proper height, a roller-type spring catch, such as those used on screen doors, will hold a folded bridge table out of the way. The rollers won't mar the table top



Prongs of a loose electric plug will hold in an outlet if they are notched with a chisel as shown



Coat-hanger wire, rustproofed with tape, can be shaped into sock driers for home or service use



Dry-cleaners' paper bags are convenient to use at home if cut short for easy removal of garments

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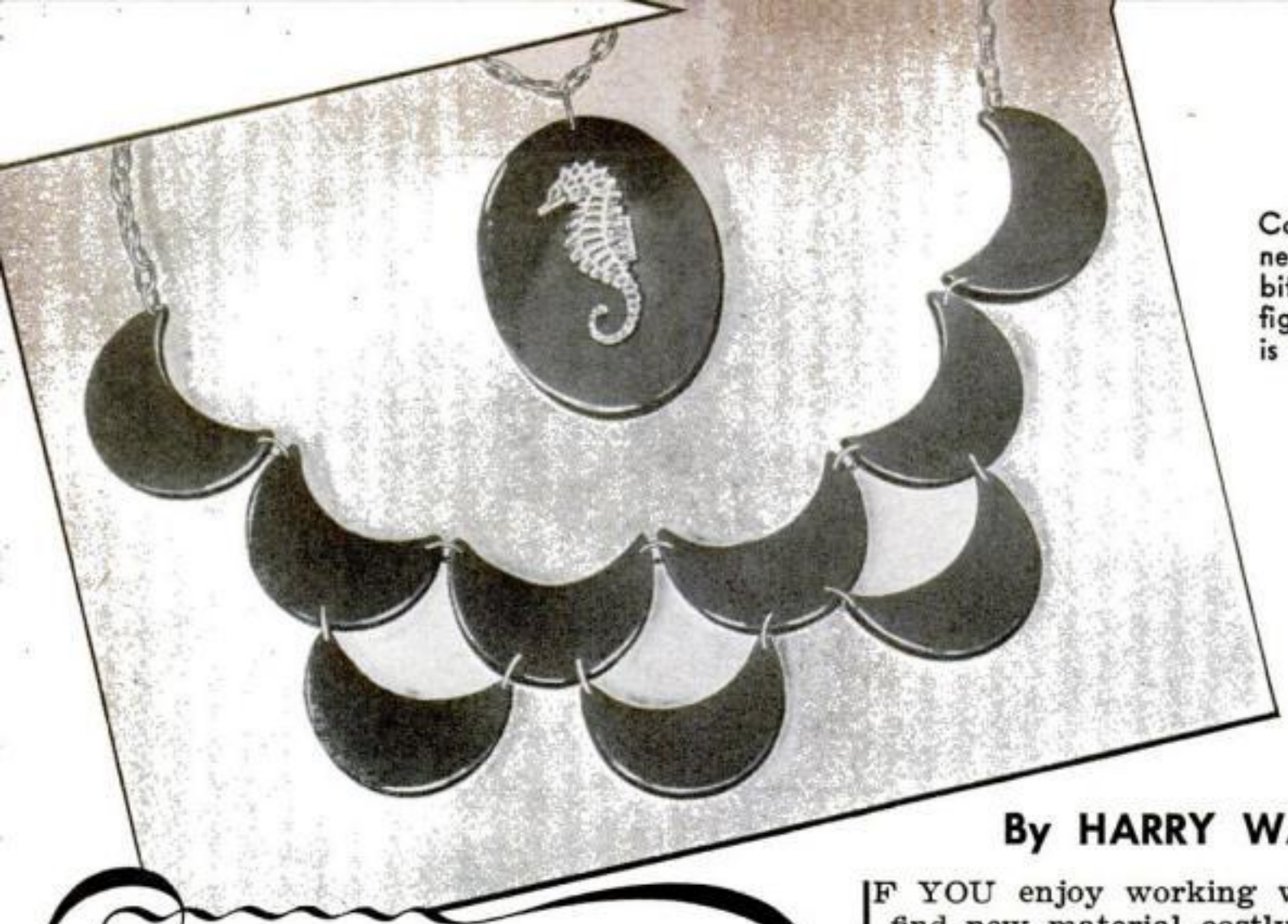


Colorful pendant and necklace shaped from bits of plastic. The figure on the pendant is from an old charm

DISTINCTIVE

Gift Jewelry

MADE FROM SCRAPS OF PLASTIC

By HARRY WALTON

IF YOU enjoy working with plastics but find new material costly or hard to get, why not use up those left-over bits in your scrap box by making jewelry of them? Very small pieces can be turned into attractive articles, and the work is fully as interesting as that of making larger projects. Simple designs can be made by any beginner; the more elaborate ones give full scope to the craftsman's skill. Jewelry articles make ideal gifts and are readily salable.

A tiny silver ornament bought at a novelty

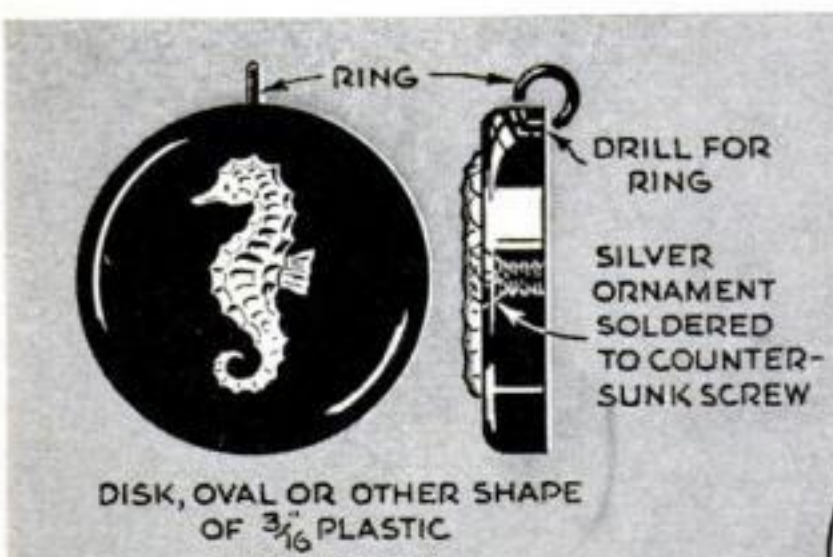


FIGURE 1

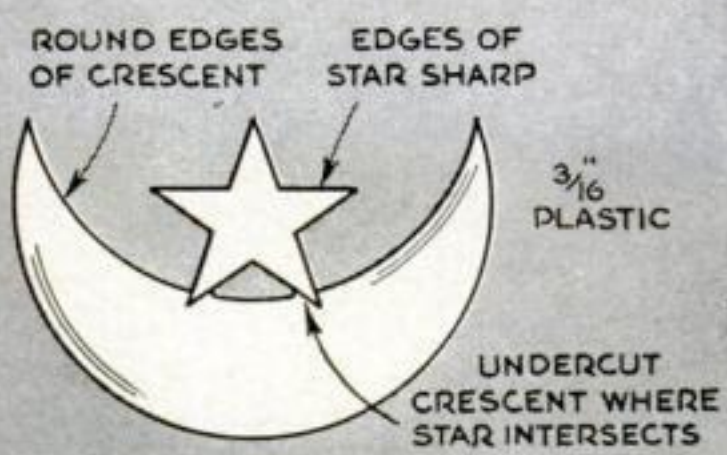


FIGURE 3

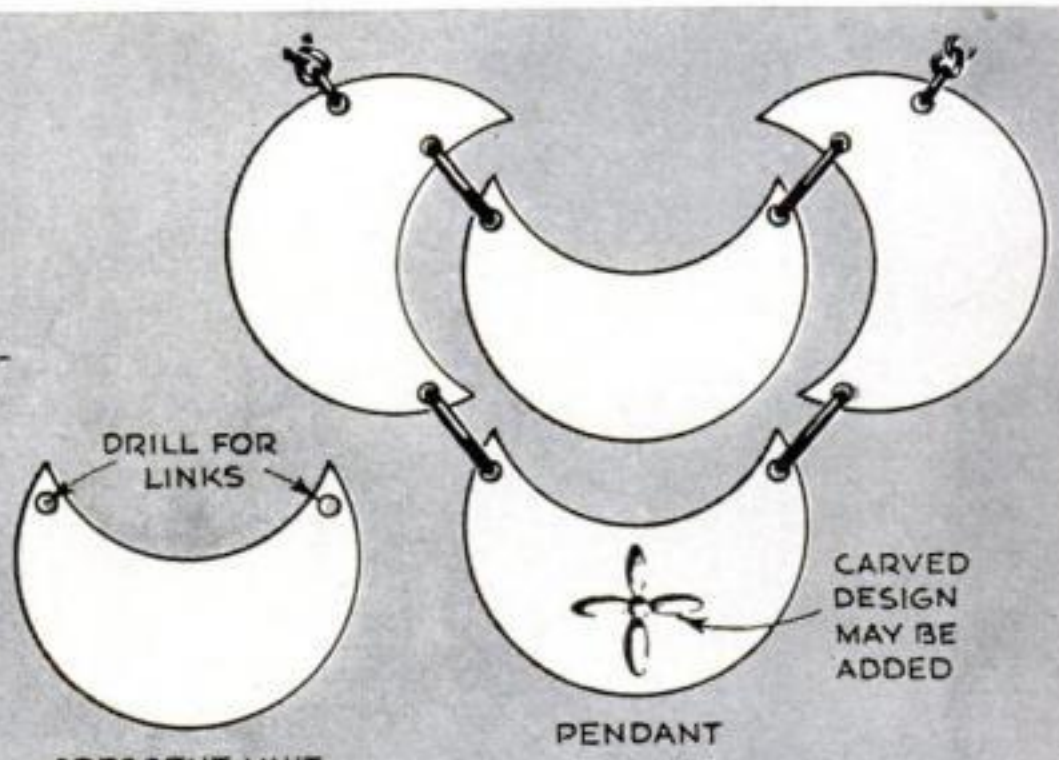


FIGURE 2

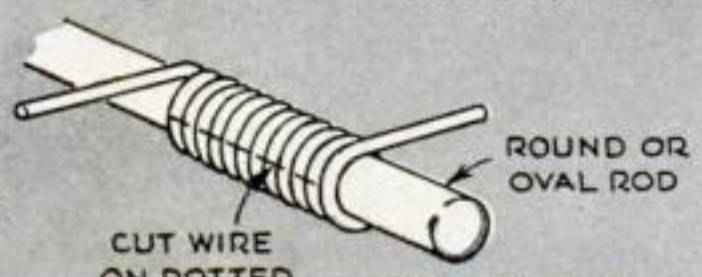
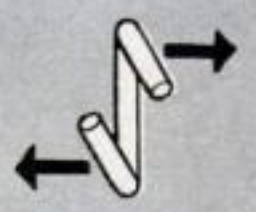


FIGURE 4



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shop, or a unit from a discarded charm bracelet, can be set off against a bit of plastic to make a brooch or pendant as in Fig. 1. The ornament is soldered to a small flathead machine screw and the plastic is tapped and countersunk to fit. The screw will cut its own threads if the hole is drilled the proper size. Drill part way from the back and part way from the edge for a chain ring. For a brooch, take the pin clip off an old piece of jewelry and tap a centered hole in it so that it can be turned tight on the machine screw from the back.

Small scraps of the same color can be used to make a crescent pendant or necklace as in Fig. 2 or the large illustration. Make a pattern of the unit in the drawing, and trace the design on paper. Paste the paper patterns on plastic scraps, cut out the crescents, and drill holes for wire links as required. The pieces can be embellished with carving if you like.

Links can be obtained from a discarded chain, or made as shown in Fig. 4 from silver wire or even silver solder in wire form, although the latter has a slightly yellowish cast.

The star-and-crescent brooch (Fig. 3) can be used as a turban or scarf pin. Be careful to keep the edges of the star sharp. Round off those of the crescent so that the star stands out clearly against it. Attach a brooch clip with escutcheon pins or drive screws. To use pins, drill the holes undersize and heat the plastic in water to enlarge them. Push the screws in while the plastic is hot, but take care not to bend it.

Monogram pins are always popular. Figure 5 suggests a circular one in two colors. Jigsaw the monogram from thin plastic, file and buff it, and cement it to a back of contrasting material.

Colorless (clear) plastic or colored transparent plastic may be used for the pendant unit shown in Fig. 6. All the carving is done on the back. An unusual relief effect, possible in no other material except glass, is seen from the front. Ball cutters were used in a flexible-shaft tool to make this piece. The last cuts should be very light, leaving a frosted surface that requires no further finishing and contrasts well with the polished parts.

The bracelet (Fig. 7) was cut from a ½" wide section of a 3" tube. Drill four evenly spaced holes for drive screws or pins, and carve any desired design between them. Cut the flowers from 1/16" plastic, and drill a hole in each. The petal markings should be thin and sharp. They can be made with a

FIGURE 5

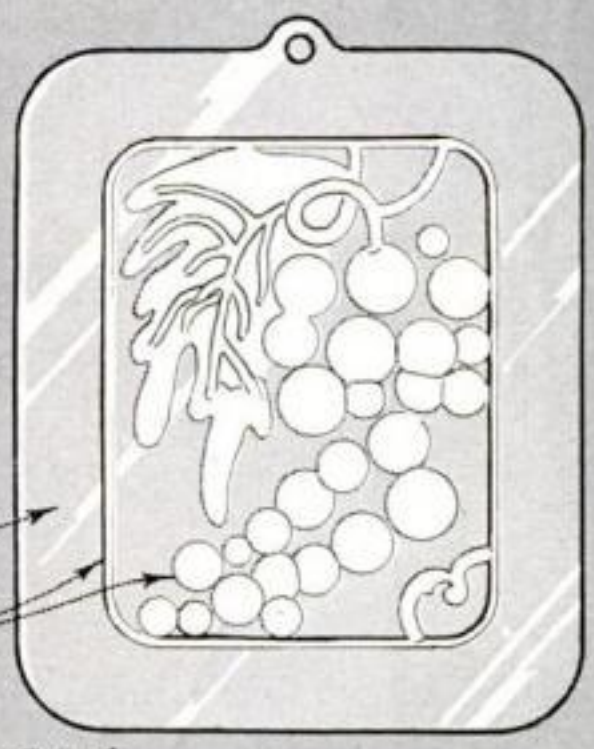

FIGURE 6

FIGURE 7

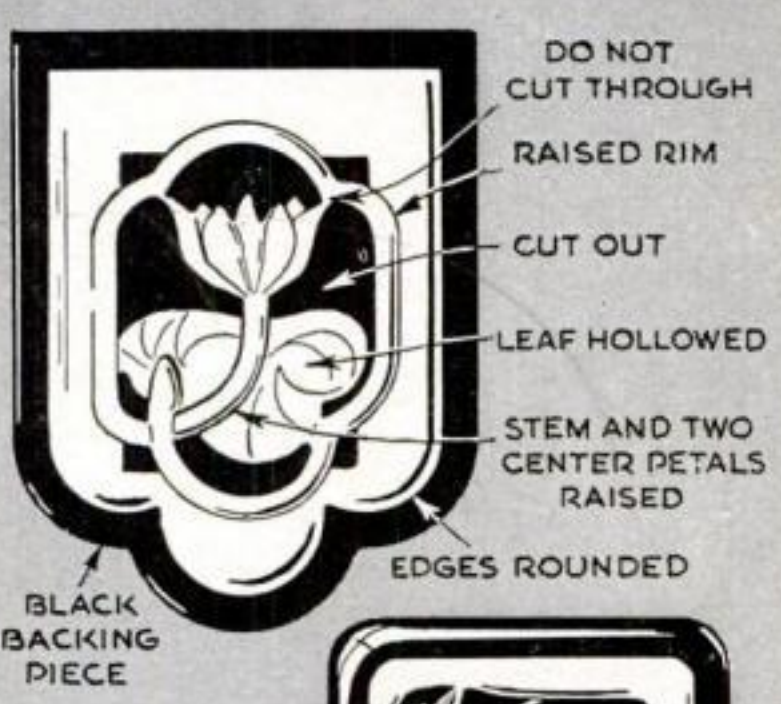

FIGURE 8

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knife-edge cutting wheel or the sharpened end of a three-cornered file. Mount the flowers on the pins with a touch of cement to keep them from turning.

To make either dress clip in Fig. 8, paste the paper pattern on 3/16" plastic sheet. Drill holes in the shaded parts so that a jeweler's saw blade can be inserted. Cut out these parts, finish with needle files, and carve the relief work as indicated. After buffing the piece, cement it to a backing of another color and attach a spring clip to the back.

Either design can be simplified by giving the shaded portions a "hammered" effect with a small ball cutter instead of cutting them out.

Old files, properly sharpened, can be used for carving plastic. Narrow strips of fine abrasive paper are useful for smoothing inside cuts. To buff such parts, pull through them a soft cord on which buffing compound has been rubbed. Before buffing, visible scratches must be removed by the use of fine abrasive paper, preferably with water.

To join plastic, use the cement made for that purpose and be sure the contacting surfaces are smooth but not polished. If they have already been buffed, roughen them with abrasive paper

This bench is made of ¾" knotty pine and has music shelves of 3/16" plywood. The unique catch is a plain piece of ⅛" thick brass, cut in a circle and hung loosely on a screw, but any preferred type may be used. This one is simply pushed aside to permit either door to open. Design by Henry R. Diamond

Children enjoy keeping tab on their own height with this device. Footboard folds up and the feet turn in for convenient storage

Children's Height Standard Folds Compactly

PARENTS like to keep a permanent record of the growth of their children, and children, too, are much interested in looking at the marks which show their height at various ages. Often this record is made in pencil on some door jamb, only to be obliterated when the room is repainted or lost when the family moves away. A much better idea is to construct a height-measuring standard of the type shown in use above. It gives the measurements at a glance and also provides a place to make permanent marks and write in the dates on which such measurements were made. In after years father and mother can drag out the standard from among other childish souvenirs and see just how high Johnny was on his ninth birthday and how much Helen grew that year she shot up so fast.

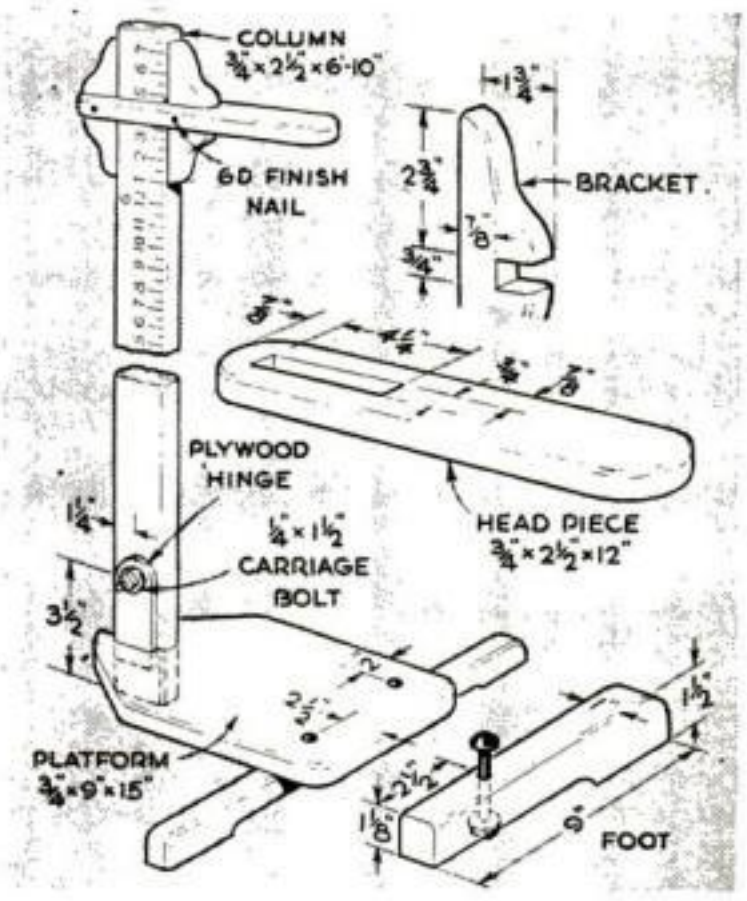
Make the column from a piece of 1″ by 3″ stock, and be careful that the edges are parallel. The head piece, made from the same stock, has a mortise to slide on the column, but this mortise is 4¼″ long so that the brackets can be inserted as shown. In fitting the column, allow room for a couple of coats of lacquer. The head piece should fit so that it will slide up and down with slight friction.

The platform is notched to fit the column. Make two hinge lugs of ¼″ hardwood plywood and set them flush into the sides of the notch, gluing and nailing them. The bolt suspends the rear of the platform and enables it to fold against the column, as in one of the photographs above.

The two feet, made of 1″ stock, are bolted so that they can be turned lengthwise under the platform, yet will extend sidewise to a width of 18″. Sink boltheads flush into the wood.

Calibrate the sides of the column at the front edge, starting 2′ from the platform. Mark quarter inches with a lead pencil, and protect the scale with a coat of lacquer.

In using the standard, mark the height of the head piece with a pencil line on the column. Date the line and rub a little lacquer over it to seal it. Each side can be used for keeping the record of one or two children.—E. M. L.



HW 497

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Two-Rail Operation

1. SWITCHES AND CROSSINGS

By David Marshall

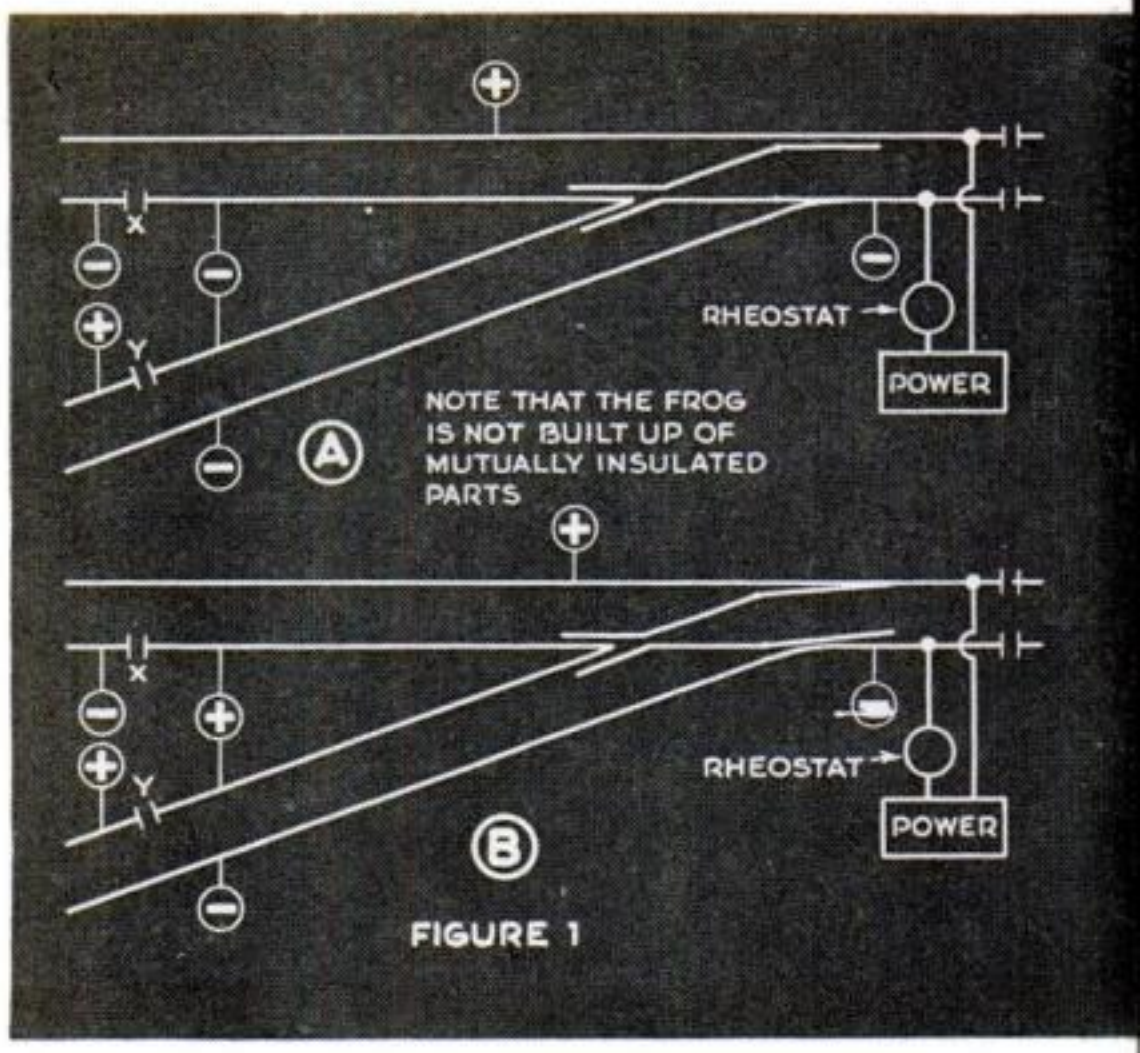

FIGURE 1

TWO-RAIL operation is the present achievement or the ultimate goal of a majority of model railroaders, and there is much to be said in its favor. It eliminates the third rail, thus (1) reducing the cost of materials, (2) saving a great deal of trouble at the switches, and (3) greatly improving the appearance of your pike. And, what is equally important, it obviates the need of outside collector shoes, which in some degree inevitably spoil the look of steam-type locomotives.

It has its drawbacks, of course, and one in particular. With two-rail operation, automatic signaling is difficult and not entirely satisfactory. If you operate a very extensive railroad where everything depends on the accuracy of your signals, two-rail work is not for you.

THE TWO-RAIL IDEA. A curious misunderstanding associates two-rail with direct-current operation. This, of course, is absurd. The two-rail system is merely a method of power distribution via the running rails; and the power itself can be either A.C. or D.C. However, the two-rail system has many characteristics which are more easily understood if we assume that we are working with D.C.

Nor is there any special connection between two-rail operation and polarized remote control of locomotives. The fact is that p.r.c. is equally feasible on a three-rail pike. As it requires us to pay special attention to the question of polarity, however, and helps illustrate some of the features of two-rail work, we assume that we are working with p.r.c. locomotives. We assume, that is to say, that by reversing the flow of electricity, we reverse the direction in which the locomotive runs.

For the rest, the two-rail system requires only that the power shall flow from its point of origin—a battery, let us say—to one of the running rails, thence through wheels to the motor, from the motor through different wheels to the opposite running rail, and back to the point of origin. The two rails represent the opposite poles of the battery, and are spoken of as the positive rail and the negative rail. Hence it follows that any conductor that comes in contact with both rails will short-circuit the power; and from this in turn it follows that cars and locomotives built for three-rail operation may not be used on a two-rail pike.

With reservations on the subject of car-lighting and signaling, it may be asserted broadly that two-rail operation requires that ordinary car wheels be made of plastic or some other nonconductive material. (Such wheels are obtainable at most model-supply stores for O-gauge cars as well as double-O and HO.) Two-rail operation further requires (1) that the pony truck and trailing truck of locomotives be equipped with nonconductive wheels; (2) that the right-hand drivers be of all-metal construction; (3) that the left-hand drivers be "busheled" by inserting a nonconductive collar between each wheel and tire, or between each wheel and axle; (4) that the side bars, connecting rods, and valve gear be carefully insulated from the left-hand drivers; and (5) that the tender have metal wheels on the left-hand side, nonconductive wheels on the right.

The flow of electricity is thus through the right-hand drivers to the motor, and from the motor back through the left-hand wheels of the tender. Standard practice further requires that the motor itself be so hooked up that a p.r.c. engine will move forward when the right-hand rail is positive, backward when the left-hand rail is positive. Failure

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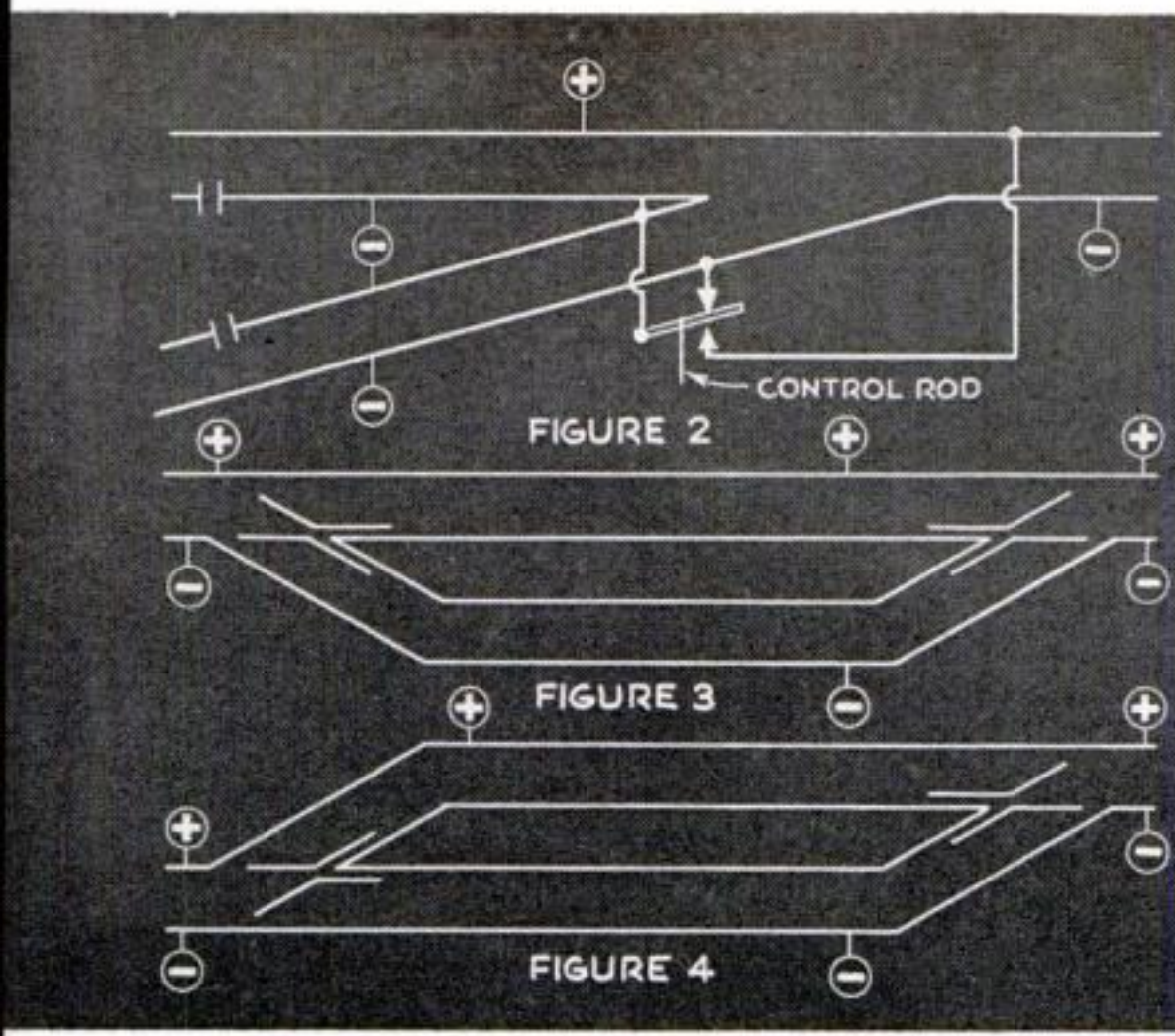

FIGURE 2

FIGURE 3

FIGURE 4

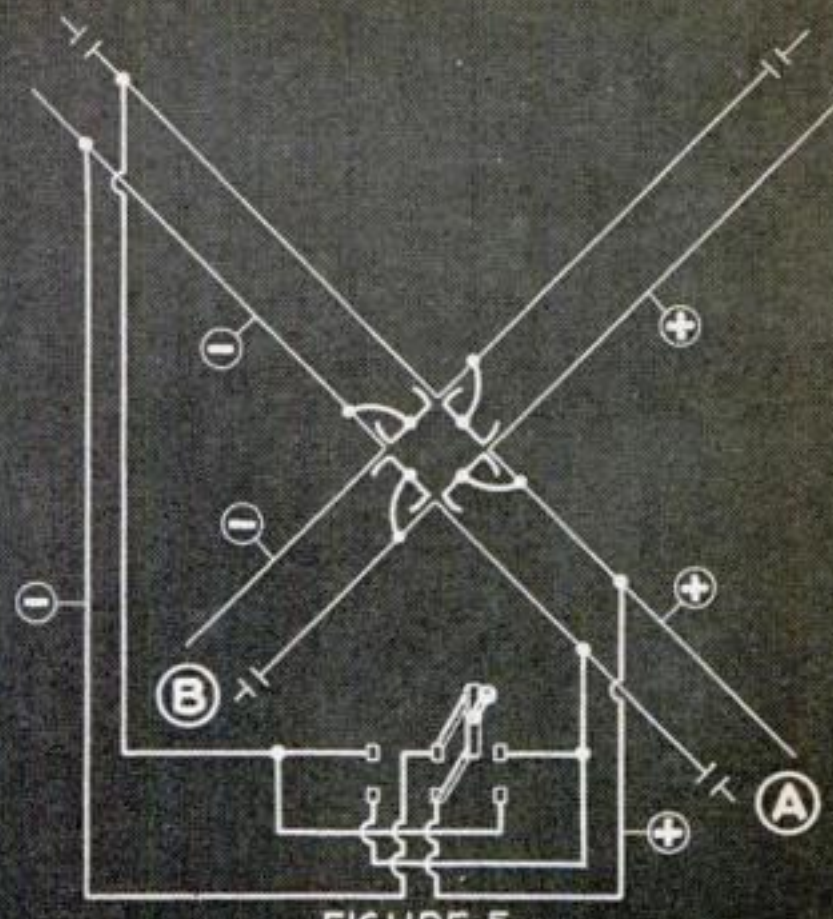

FIGURE 5

to achieve uniformity in this last respect can cause no end of riot—though in the case of non-p.r.c. locomotives it doesn't matter.

TWO-RAIL SWITCHES. The sketches in Fig. 1 show some of the unusual possibilities of two-rail work. Here we have a single-track junction. In *A*, the switch is closed, lined up for the main, or through, route; while in *B*, it is open, lined up for the diverging route. Observe these points: (1) the two stock rails alone receive power directly from the battery; (2) from the switch points to the insulation at *X* and *Y*, the whole interior structure—points, lead rails, frog, and heel rails—forms a single electrical unit, without any insulated parts; (3) this interior unit receives its power indirectly from one or the other of the stock rails, depending on whether the switch is closed or open, the necessary contact being formed actually when the switch point freezes against the stock rail; and (4) as a result, the route established receives power, while the other route goes dead, with either a minus-minus, as in *A*, or a plus-plus, as in *B*.

Obviously, this is not merely a junction, but something of an interlocking plant all in itself. In *A*, the gates are lined up for a train to move along the main line from east to west. But any train approaching from the southwest, along the diverging route, would have to stop for power failure well before it came within fouling distance of the main line.

CONTACT INSURANCE. Can the switch point, pressed firmly against the stock rail, provide as good a contact as will be required for our purpose? That depends on the accuracy of your craftsmanship. In any case, you can insure the contact by hooking up—down below the table work—a pair of auxiliary contacts plus an armature that moves from the one to the other in response to each movement of the switch motor. Such an arrangement is roughed out in Fig. 2, the control rod being, if possible, an actual extension of the tie-rod which operates the points.

PASSING SIDINGS. Many elaborate track patterns can be worked out in strict accordance with the principles in Fig. 1. In Fig. 3, for example, we have an entire passing siding, of which one track must always be dead. In building this, simultaneous switches are required—switches that open together and close together. This result is achieved if both are operated by the same motor, or if separate motors are connected in parallel.

For the type of siding shown in Fig. 4, reversing switches are required. One must close on the same electric impulse that opens the other. This is achieved by connecting the switch motors in parallel so that both move in opposite directions on one surge of power.

CROSSING. The guard rails are left out of the crossing frog in Fig. 5 for the sake of simplicity. As they have to be insulated from the rest, they may as well be built up of wooden rails. The closing of the double-throw knife switch is required to establish either route through the crossing, whereupon—you've guessed it. The established route is absolutely protected against any fouling train movement from either side.

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Mobile

Pacific Coast Wardens Build Emergency Defense Equipment

By BLAINE KLUM

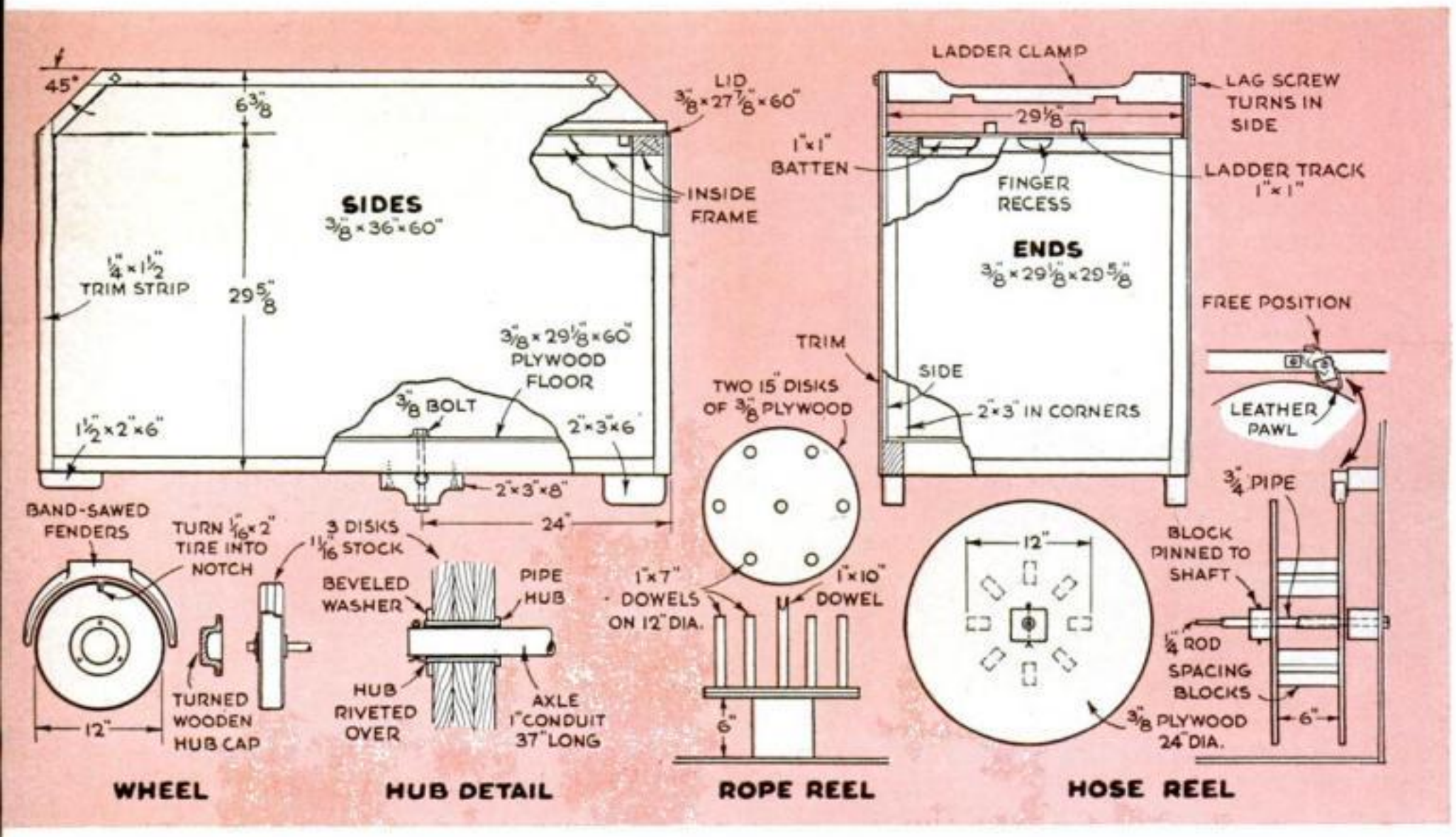
CIVILIAN-DEFENSE wardens of Area 463 of Oakland, Calif., have built five fire-fighting carts as part of their emergency preparedness program. Each of these cost about $75 fully equipped. The work was done in the writer's home workshop and in nearby garages. Home owners in the area contributed to a fund for the purchase of materials.

The sides, endpieces, bottom, and lid of each cart were cut from ⅜" plywood. Both endpieces are set within the sides, and an inside frame of 2" by 3" stock is attached with nails and screws all around at the height of the endpieces—29⅝". Gussets or shelf brackets screwed fast under this frame reinforce the corners. All the outside edges are finished with ¼" by 1½" trim strips.

Vertical 2 by 3's nailed into the four inside corners were cut ⅜" short so that the plywood bottom could be set in against these flush with the sides. An extra framing of 2 by 3's was then nailed around the bottom from beneath. Rounded bumpers nailed to this project 3" below it at the front corners and 1½" at the back ones.

A 2" by 3" locking bar, shown in the photograph on the facing page, fits into three U-shaped metal brackets bolted to the rear

Interior of a cart with lid removed. Notched crosspieces pivot on lag screws that turn in copper-tube bushings. When turned down, these cross members clamp the ladder down against the lid. Below, the working drawings



HW 500

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Fire-Fighting Units

endpiece. Near the top of this bar a hasp is attached and bent to fit around one rung of the 24′ extension ladder, to which it can be padlocked.

In this position, the locking bar tilts the cart forward on its front bumpers so that it cannot be moved. When unlocked, the bar can be raised and held up by a second metal clip, which hooks over the ladder rung instead of the hasp. The cart can then be moved. The projecting part of the ladder serves as a handle.

A ⅜″ plywood lid rests on the inner framing between the sides. Two 1″ by 1″ battens nailed to the underside of this lid keep it from sliding lengthwise. Similar strips on top form a track for the ladder, which is clamped down by cross members mounted off center on lag screws. When turned up, the cross members leave enough clearance to allow the ladder to be pulled out.

The lag screws turn freely in bushings made from short pieces of copper tubing and driven into the wooden sides of the cart.

Wheels were made from fruit-box ends 11/16″ thick. Disks 12″ in diameter were first sawed out, and three glued together with waterproof glue, the grain of them crosswise, for each wheel. The wheels were trued to a diameter of 11⅞″ on a lathe. Tires are of 1/16″ by 2″ band iron.

Hubs consist of short pieces of heavy-walled pipe, turned with a narrow shoulder at one end to a tight fit in the wheels. A large washer having a beveled inside edge was slipped over each hub against the wheel, and the hub riveted over this.

A 37″ length of 1″ conduit that is a close fit in the hubs serves as the axle. After the hole for it had been bored in both axle blocks, the latter were sawed lengthwise tangent to the hole. A ⅜″ bolt through each block, the axle, and a bottom frame member clamps all these parts tightly together.

Each side of the hose reel consists of two 24″ disks of plywood nailed together. Eight spacer blocks are nailed between the sides. The axle is a 28⅜″ length of ¾″ pipe set in blocks fastened to the sides of the cart. A third block secured to the axle with a cotter pin holds the reel in place.

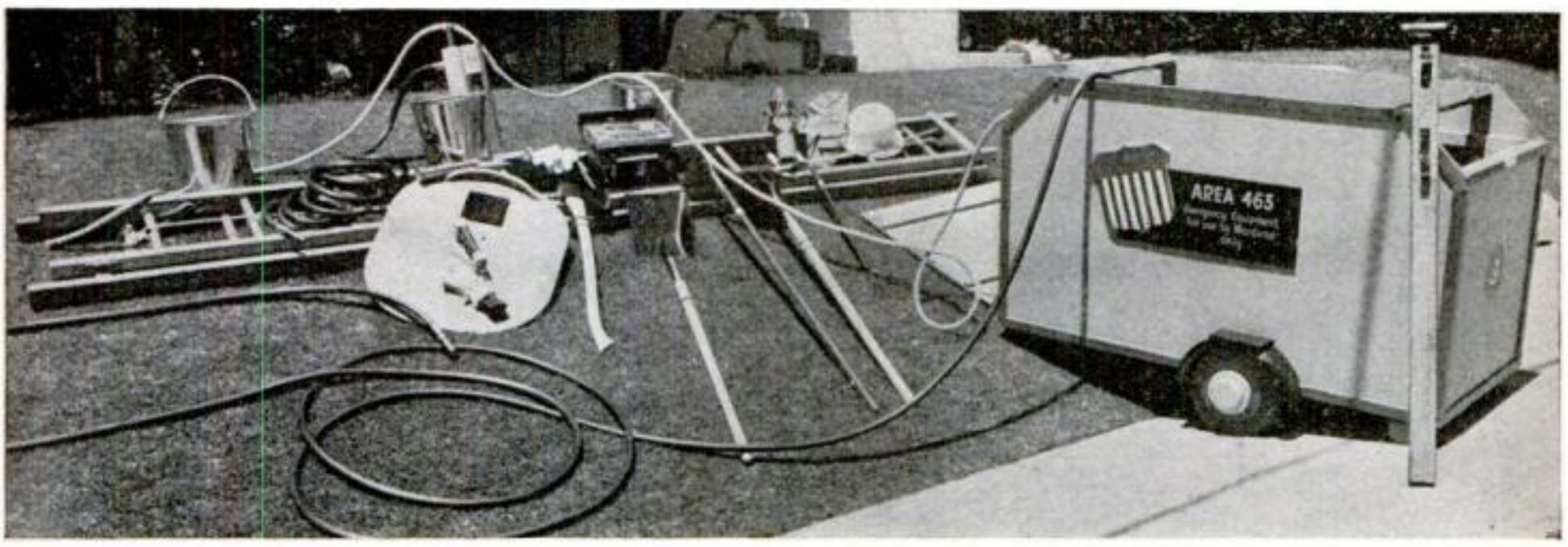
A 2″ by 3″ cross member is screwed to the top of this block and to the adjacent one on the side of the cart. Dowels in this keep long-handled tools properly spaced. The reel holds 100′ of ⅝″ garden hose. A pawl consisting of a wooden block with a leather loop nailed to it prevents accidental unwinding of the hose.

The rope reel does not revolve. Rope is wound first around the outside of the dowels, then around the inside. Tuck the end into the notch of the center dowel.

Fire-fighting equipment was selected with the help of the Oakland Fire Department. Besides the extension ladder, hose, and 50′ of ¾″ rope, it includes two square-nosed shovels, a hoe, a 3-lb. ax (firemen advised against lighter axes), a 30″ wrecking bar, a stirrup pump, three large milk buckets, a flashlight, and a pair of cotton gloves.

Each cart is equipped also with a 26″ by 30″ oval shield for use in approaching incendiary bombs. Made of plywood, it is reinforced along half of the top edge by a 2″ wide band-sawed piece of wood. Below this is framed a 5″ by 5″ piece of colored shatterproof glass. The handle is set diagonally slightly below the center of the shield, as may be seen in the photograph below.

One mobile unit holds all this equipment. Note the locking bar at extreme right. Carts were given an undercoat and two light-gray finishing coats. Trim was painted dark gray, wheels red and black



HW 501

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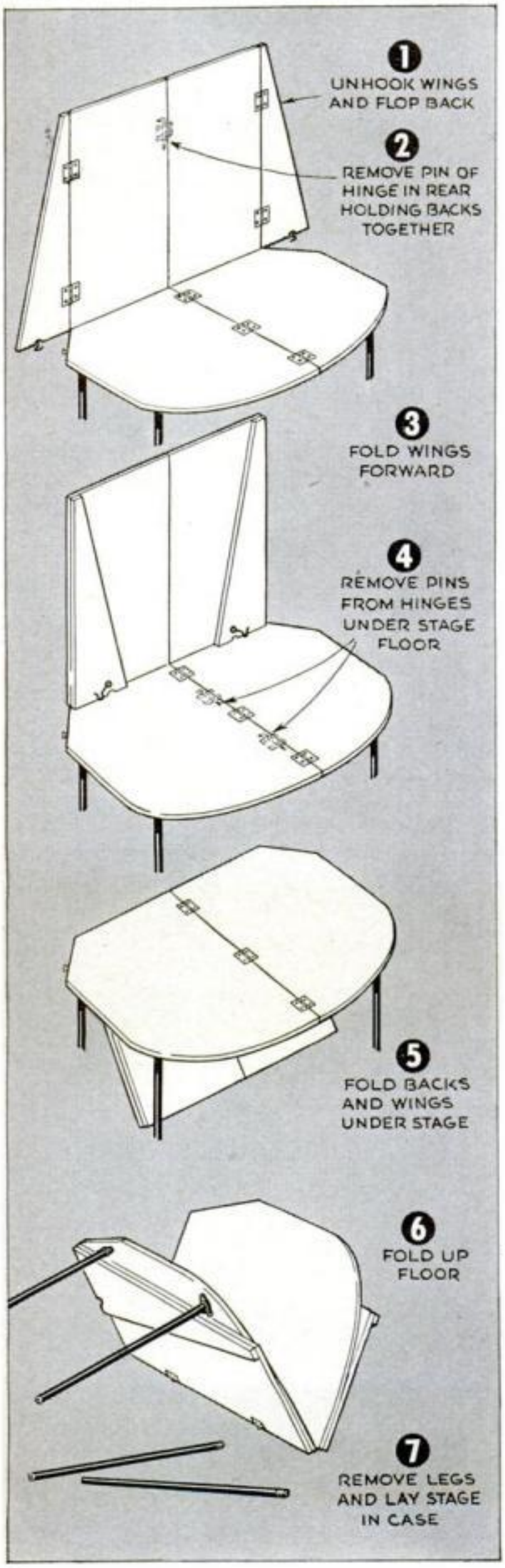
PORTABLE MARIONETTE

By LESLIE P. GUEST



BUILDING and operating marionettes is a fascinating hobby, but suitable stages for presenting them are a problem. Most stages are heavy, cumbersome, and expensive, and take too long to set up and knock down, especially at Army camps where conditions are often not ideal.

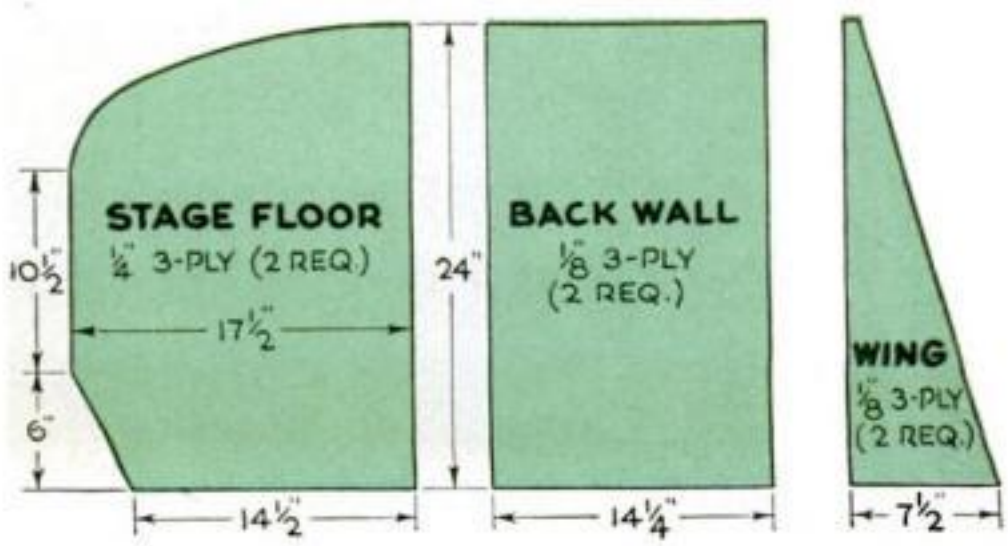
The stage illustrated, however, is light, strong, attractive, and inexpensive to construct, yet it is suitable for all marionettes, both amateur and professional, up to 20" in height. When folded flat, it fits into a box no larger than a suitcase and leaves room for a few marionettes. The whole thing can be packed or set up in two minutes. Only the four legs and three nails, used as hinge pins, are separate. The original stage has seen three seasons at school assemblies and is still in good condition.

There are no curtains or draperies concealing the operator. However, if a small spotlight is directed on the stage alone and all other lights put out, the emphasis is on the show, and the operator is hardly noticeable.

The floor of the stage is made of two pieces of ¼" three-ply stock. The two sections are permanently joined by three small hinges on the upper surface. They scarcely show when painted the same color as the floor. In attaching hinges to such thin material, use split rivets, hammering them flat and tight.

Two so-called "pin hinges" on the undersurface keep the floor rigid when it is set up. Take ordinary, cheap butt hinges and separate the leaves by driving out the pins. Screw the halves on where the joints are desired. Then, in setting up, force a nail, bent L-shaped, through each of the pairs to connect them.

The back wall consists of two pieces of ⅛" three-ply stock. Fasten these permanently to the underside of the floor by means of long strap hinges, so attached that the back will



HW 502

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THEATER

stand up straight, but can be swung back and under until it lies flat.

Two ornamental wings are cut from two pieces of ⅛" three-ply stock and are permanently hinged to the back wall. Attach the hinges so that the wings may be folded forward flat against the back wall. Be sure to allow clearance for velvet drapes on both surfaces.

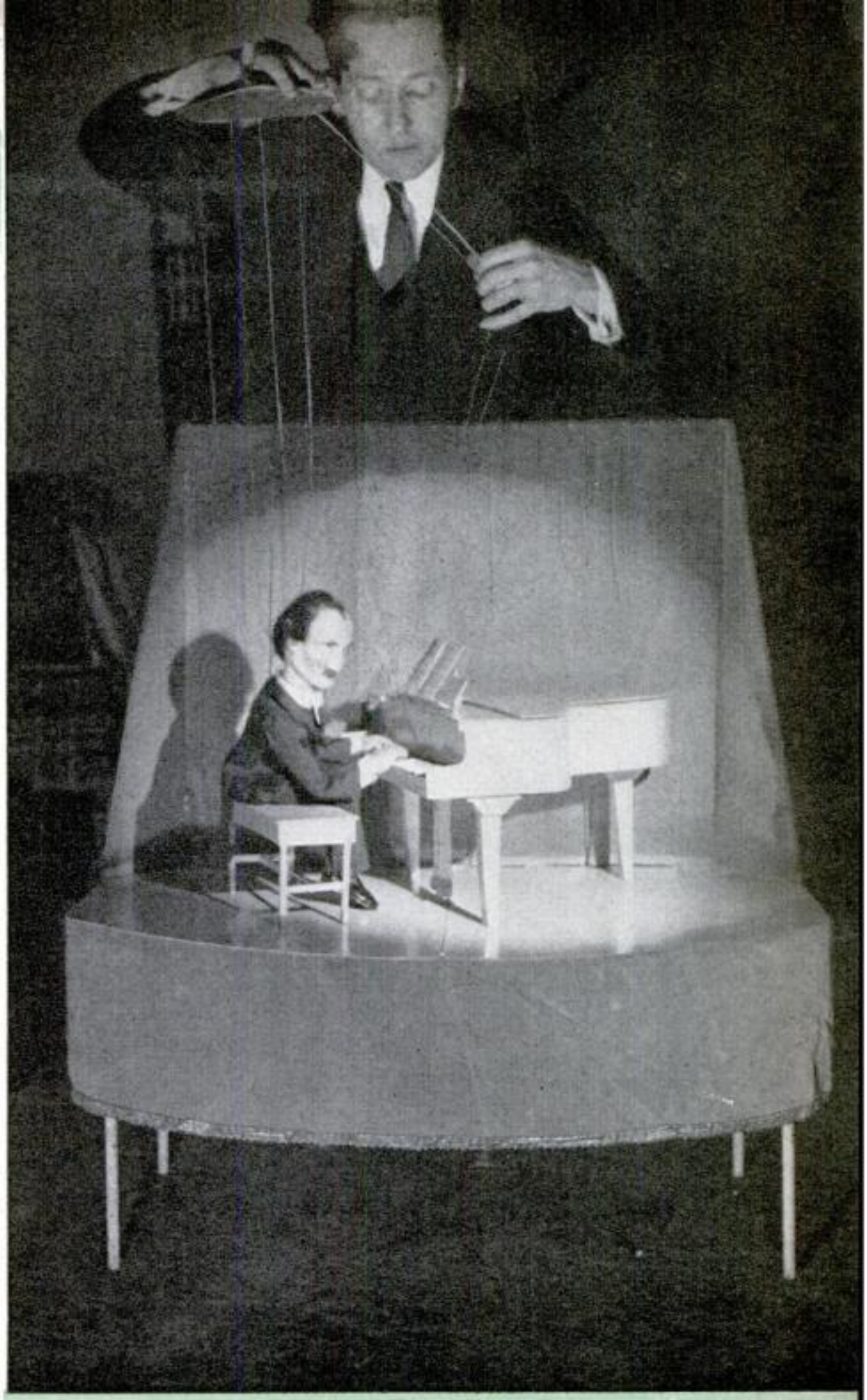
Insert a large roundhead screw in each side edge of the stage floor near the rear, allowing about ⅜" to project. Cut notches in the bottom edges of the wings, so that they can be set down over the shanks of the screws for a snug fit. Swinging brass hooks on the backs of the wings then engage the screws and lock everything into position.

A removable pin hinge, on the back near the top of the back wall, holds the two sections of the wall neatly in line.

For legs, cut four 16" lengths of ½" iron pipe. Thread an end of each to fit small oval flanges—the kind attached by two screws each. Mount the flanges near the outer corners of the stage, leaving clearance for folding the back.

The floor and legs are enameled. Cover the front of the wings tightly and smoothly with velvet, and run pleats along the back wall, using an overlapping pleat for the break at the center. Fasten all pleats at top and bottom, or they will fall out of position when the theater is folded. A velvet skirt hangs from the front edge of the stage; this may be short or reach to the floor. It is better to attach it with snap fasteners to permit removal for careful folding in packing.

The carrying case is made of four pieces of ½" stock nailed or screwed to form a frame with inside dimensions of 25" by 18⅛" by 5¾". Using plenty of 1" thin wire nails, cover the top and bottom of the frame with ⅛" three-ply stock; then saw it all the way around to form a box and lid.



No curtain is needed to conceal the puppeteer when a spotlight is directed on the stage. This lessens considerably equipment required for the traveling show

Stage, back wall, and wings are hinged to fold flat for packing neatly in a carrying case. There will be room left over for storing a few marionettes and your props

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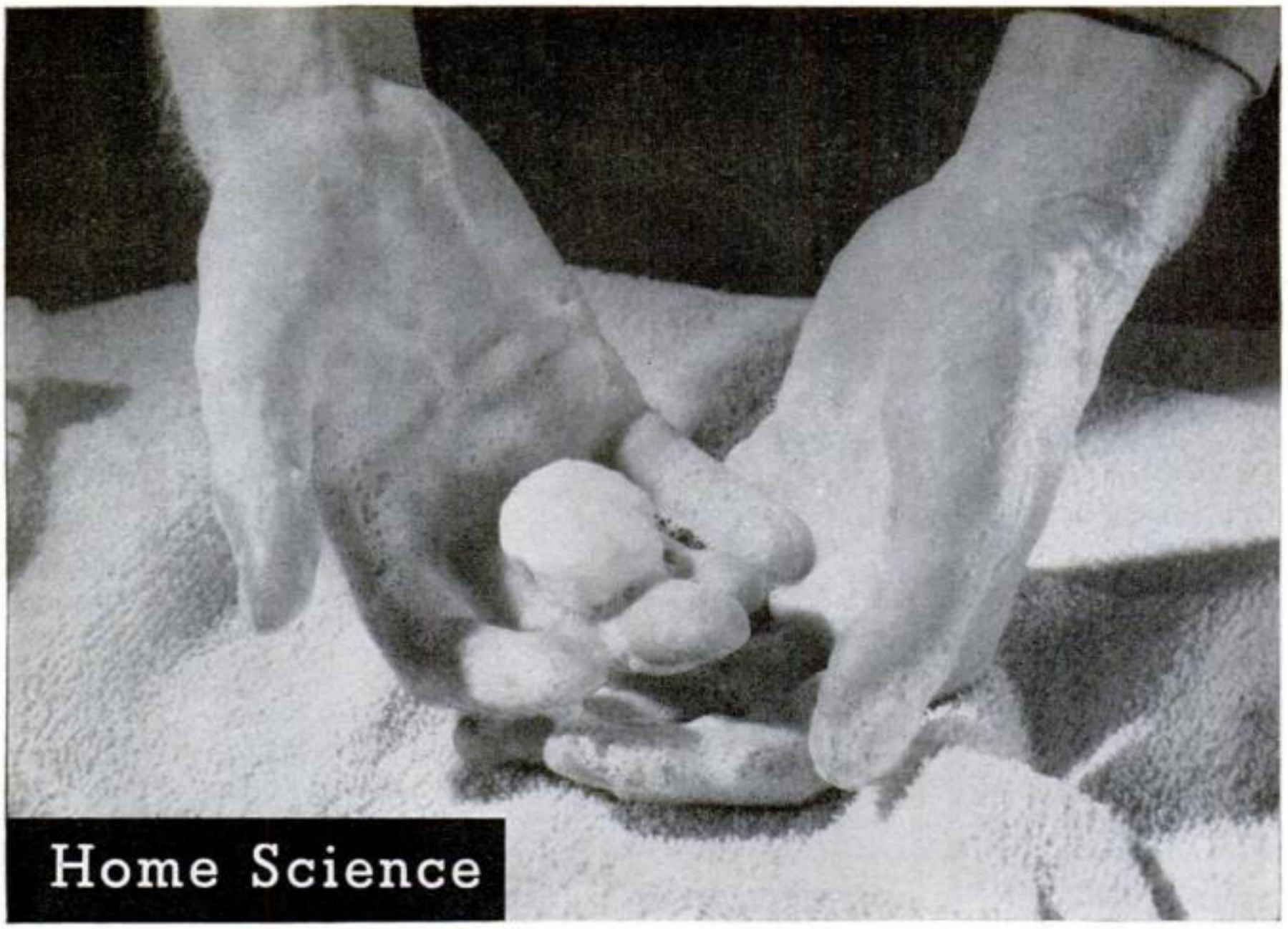
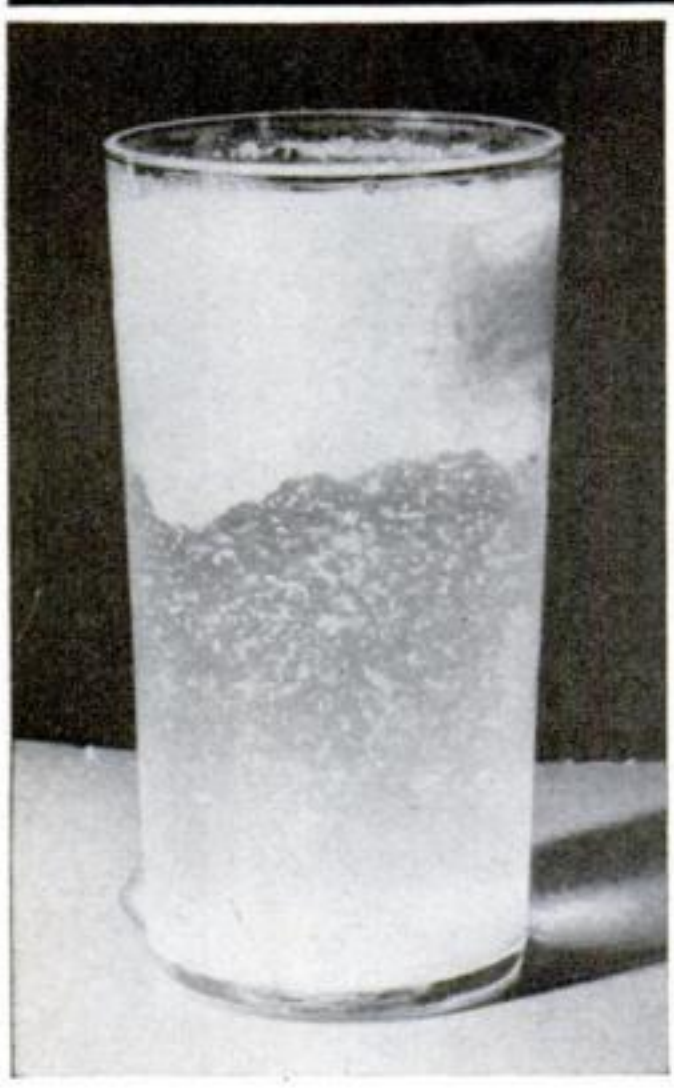


Home Science



It is a simple experiment in the home laboratory to make soap that works up a good lather and does an efficient washing job

WHAT FATS DO

THEIR ESTERS USED FOR MAKING SOAP, SCENTS, AND EXPLOSIVES

Soaps are metallic salts of fatty acids. In a beaker or tumbler put a strong solution of sodium hydroxide, or lye, and olive or other vegetable oil, mix thoroughly, and let stand for several days. Then, if you add a strong solution of common salt, the soap will separate after a short time and float to the top, as above

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KITCHEN-FAT salvage is turning American homes into an important source for war materials. Fats make soap and, more important, the glycerin needed in nitroglycerin dynamite, compasses, recoil and depth-charge mechanisms, gears, and hydraulic equipment.

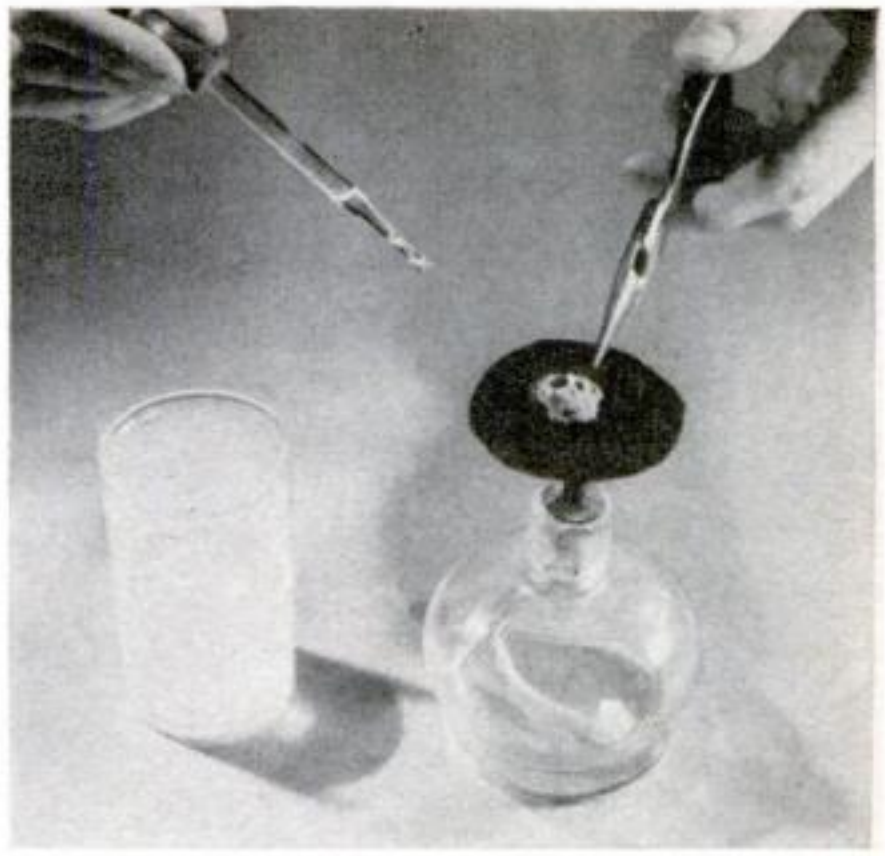
You can make soap from fats in your own laboratory, deriving glycerin as a by-product, change oils to solid fats, and investigate the strange family of *esters*, of which fats, oils, scents, flavors, and nitroglycerin are members.

Esters are really salts, but unlike those formed by a metal and an inorganic acid, they are *organic* salts from the reaction between an alcohol and an organic acid. Fats are esters formed by the reaction between glycerin (or glycerol) and a fatty acid.

Soap and glycerin are made by breaking down fats or oils, combining the fatty acids with sodium hydroxide for hard soap or potassium hydroxide for soft or liquid soap, and getting glycerin as a by-product. Olive oil gives best results, but lard, butter, or any fat will serve. Put 50 cc. into a beaker, and add a cold solution of 8 grams of sodium hydroxide (lye) in 50 cc. of water. A reaction, called saponification, sets in and continues for two or three days, thickening the mixture and precipitating soap, which can be made to rise to the top by adding an ounce of common salt dissolved in 200 cc. of water. Scooped off and dried, it can be used for washing your hands. If it is too greasy, it contains too much oil; if harsh, too much alkali.

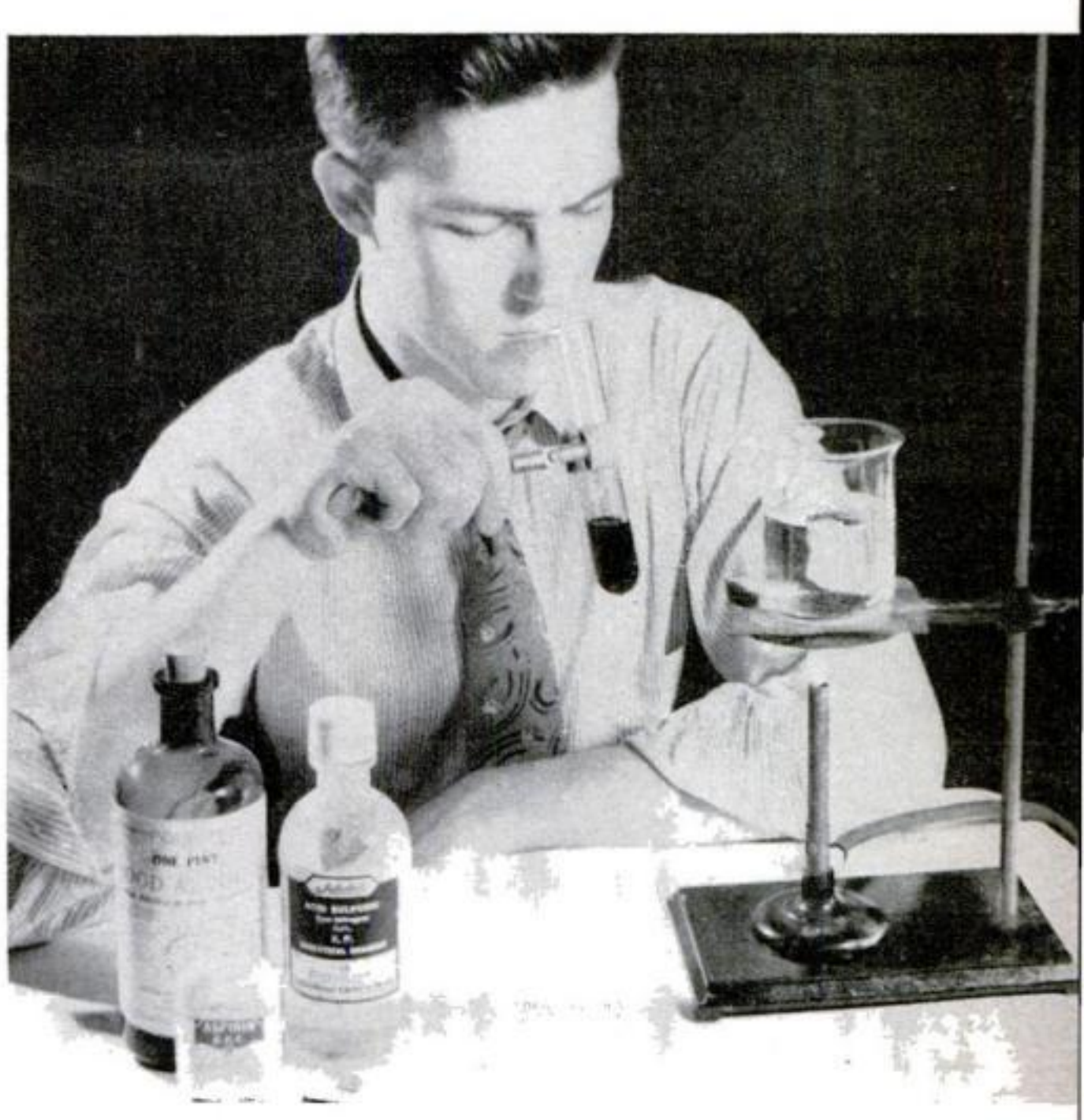
Glycerin remaining in the beaker is diluted and impure, but may be detected by heating several drops on a piece of clean tin. The offensive odor given off is characteristic of burning fat, and is acrolein, a gas formed by decomposition of glycerin.

Using esters, natural in fruits and flowers, chemists imitate flavors and scents, and even create new ones. Oil of wintergreen is made by a reaction between methyl (wood) alcohol and salicylic acid. Put a little salicylic acid in a test tube (powdered aspirin tablets will do), add wood alcohol and a few drops of concentrated sulphuric acid, plug



GLYCERIN IS A BY-PRODUCT of soap making, left in solution when the soap is taken out. A few drops heated on a piece of tin will give off an offensive odor that indicates its presence

OIL OF WINTERGREEN IS AN ESTER, or salt, of methyl alcohol and salicylic acid, and is made by warming these two chemicals together in the presence of sulphuric acid, acting as a catalyst. Its strong, pleasant odor is easily recognizable



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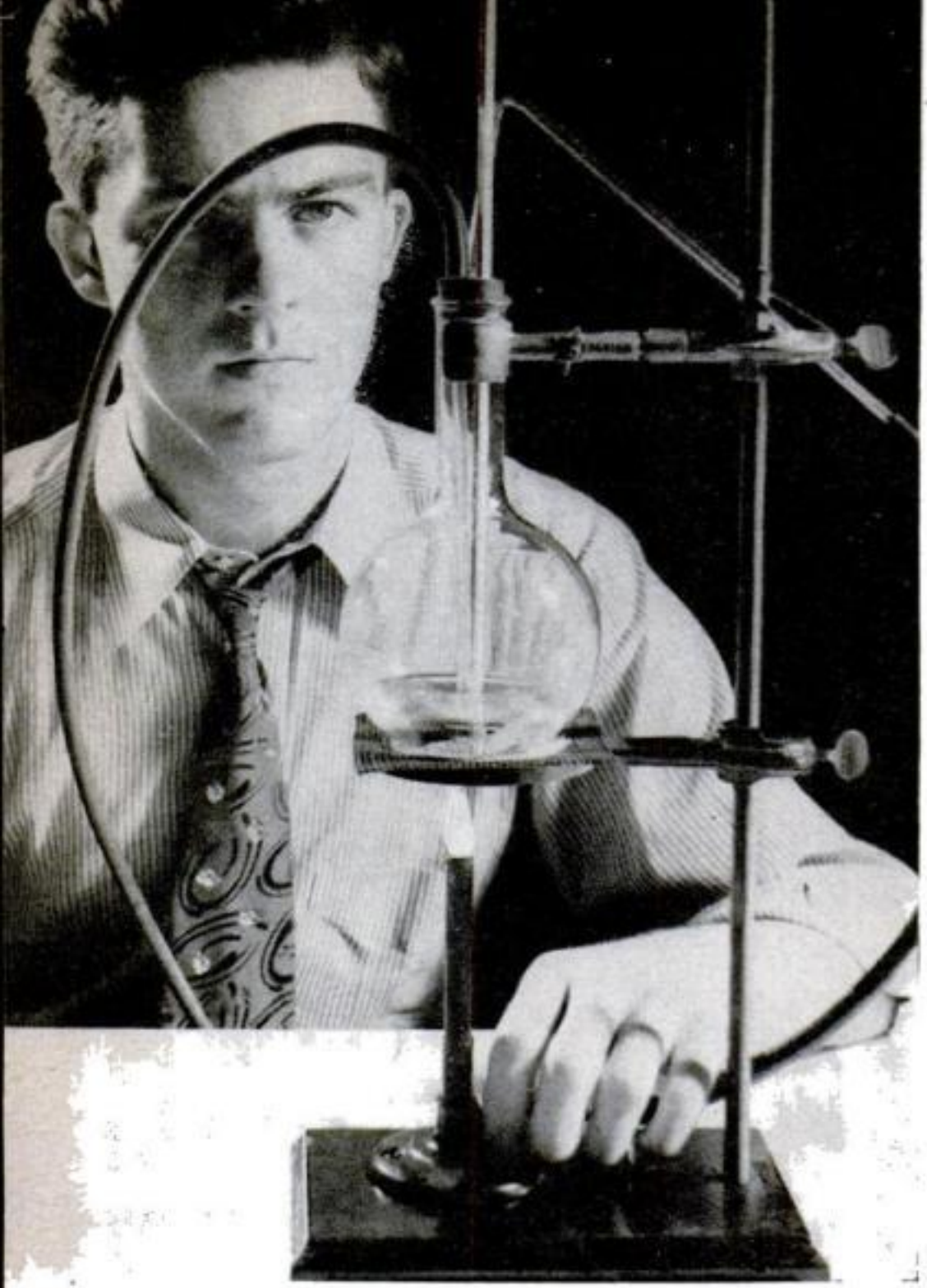

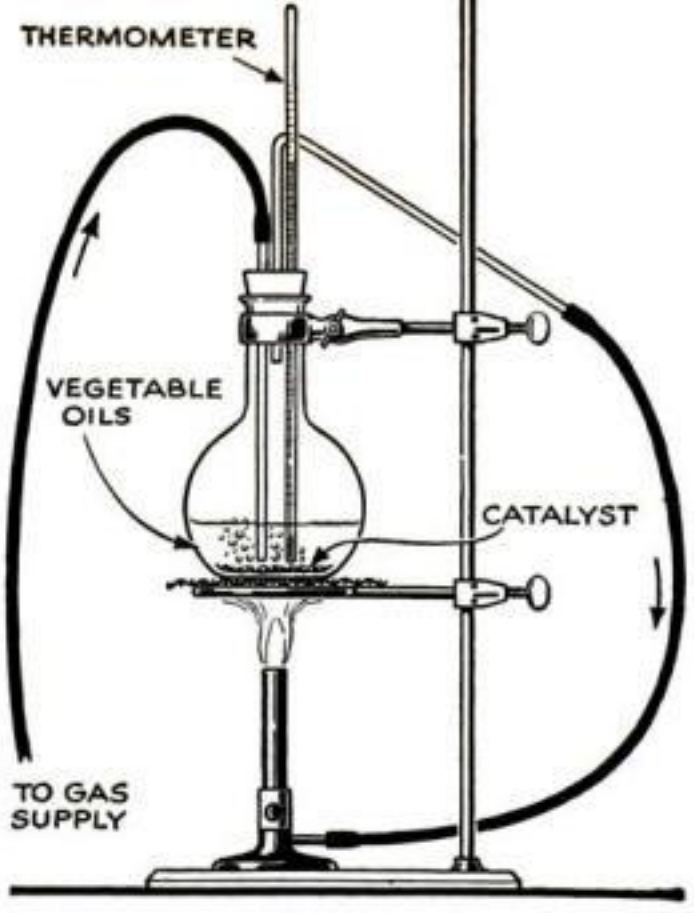

Setup for changing oils to solid fats

Hydrogenation builds up vegetable oils into solids. Above, illuminating gas bubbled through supplies the hydrogen. Waste gas is piped to the Bunsen burner

Linseed oil is one of the type that oxydizes in air to form a tough film. A piece of paper, painted with the oil as at right, demonstrates the principle

the opening, and stand the tube in warm water for 15 minutes, after which a strong odor of wintergreen will be apparent. The sulphuric acid, a catalyst, hastens the reaction.

Linseed oil is a fat containing esters of linoleic and linolenic acids. Air oxydizes the oil, changing it into a tough skin. Paper or cloth saturated with it becomes stiff when dry, the principle use in making linoleum.

Because many housewives, accustomed to lard and butter, want solid cooking fats, chemists make liquid oils semisolid by "hydrogenation"—building up molecules of cottonseed or other vegetable oil by adding extra atoms of hydrogen. Finely divided nickel, acting as a catalyst, makes the reaction possible. Try it by adding a solution of sodium hydroxide to a solution of nickel sulphate, chloride, or nitrate. When the precipitated green nickel hydroxide settles, pour off the clear upper liquid. Add fresh water, shake, and pour off, repeating several times to wash away impurities, then filter and dry the precipitate.

Place this dried chemical in a ½" hard-glass tube, one end of which is led out a window, and pass illuminating gas through for 15 minutes, meanwhile heating the outside of the tube almost red. Free hydrogen in the gas changes the nickel hydroxide to metallic nickel. Put this in a flask, add cottonseed oil, and close the flask with a three-holed cork containing a thermometer and two tubes, as shown in the diagram above. Bubble a small flow of illuminating gas through the oil, leading the used gas through the bent tube to your Bunsen burner, which should be lit and adjusted to heat the oil to 200 deg. C. After 20 minutes, let the flask cool. The oil now should have solidified.
—KENNETH M. SWEZEY.

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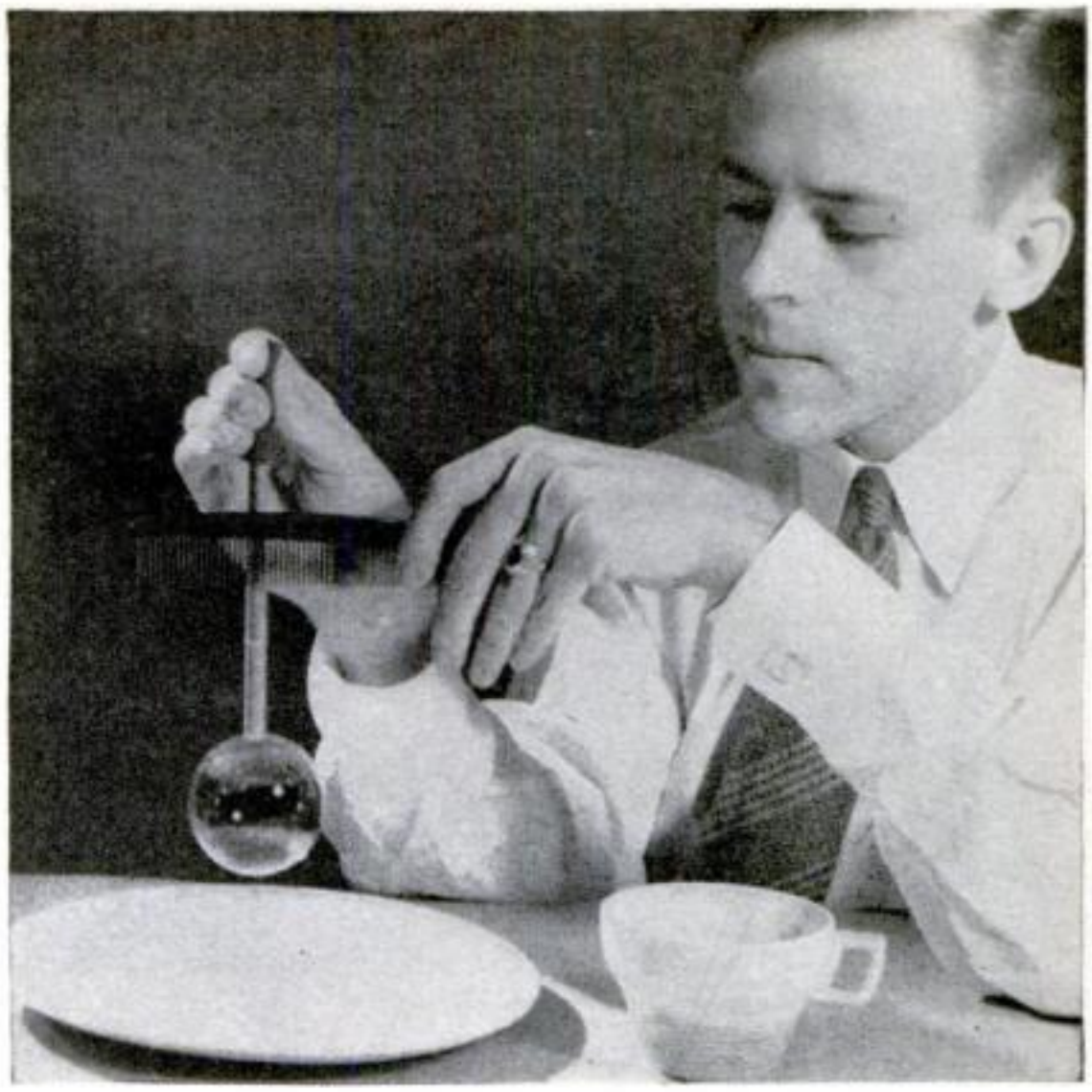
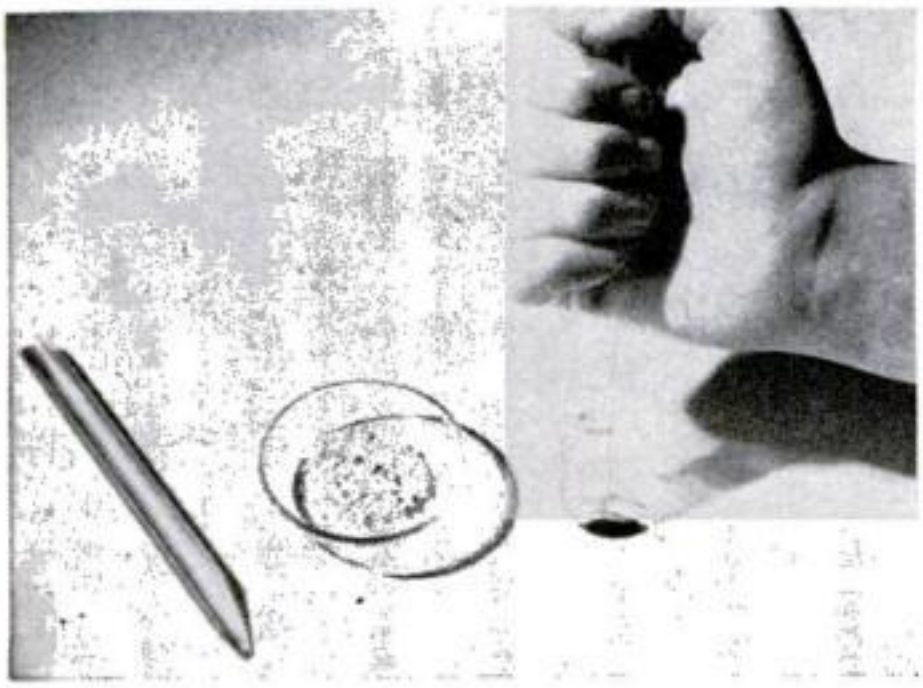
home EXPERIMENTS

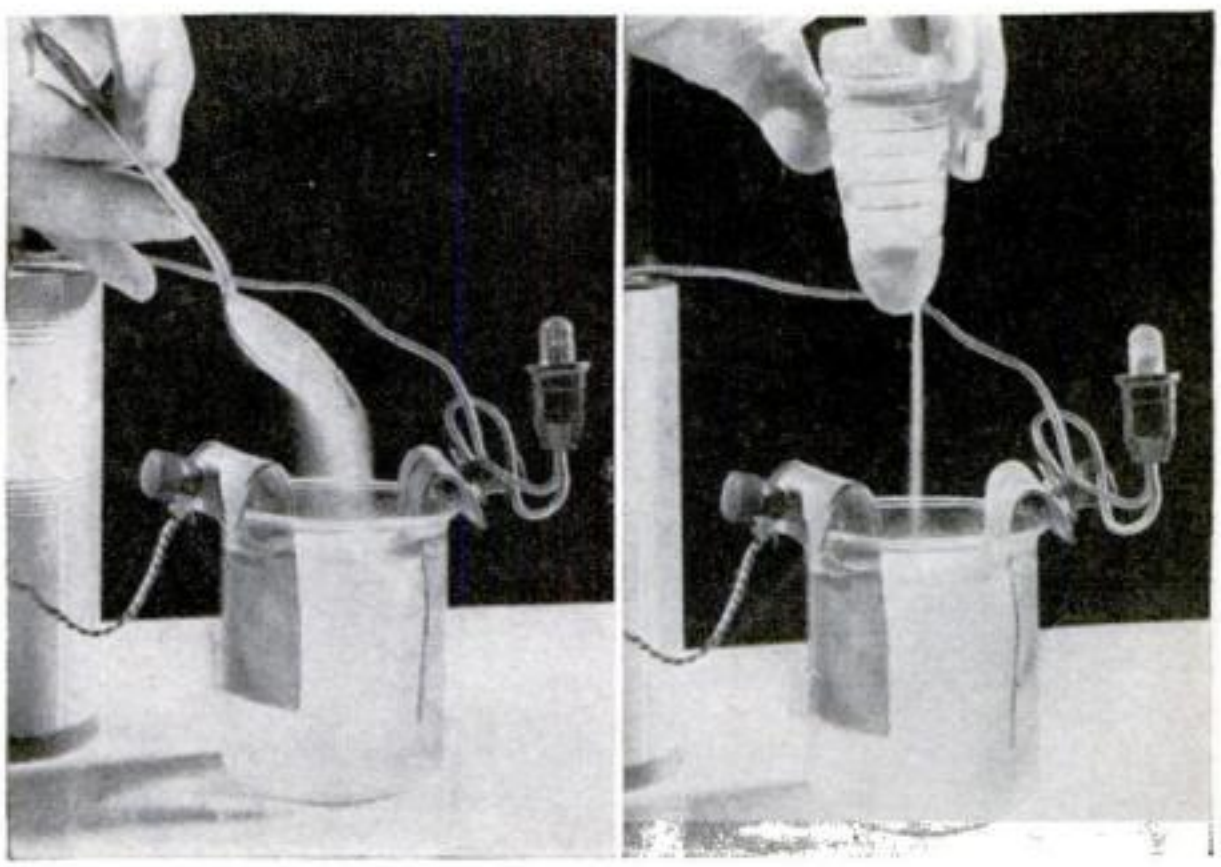


ELECTRIFIED BUBBLE EXPANDS. To show that electrified particles repel each other, join together short pieces of metal and rubber tubing, and blow a soap bubble on the end of the metal tube, pinching the rubber to keep in the air. Electrify a hard-rubber comb by rubbing it briskly on wool, then touch the comb to the metal. Mutual repulsion of the electrified air particles inside will expand the bubble. To insure the success of the experiment, choose a dry day on which to do it, and also be sure your hands are dry.



SIMPLE TEST FOR WATER. Heat a few crystals of copper sulphate in an old spoon until the crystals lose all their water and crumble into a white powder. As long as this copper sulphate is in the dry, or anhydrous, state it is an excellent indicator of the presence of water that is mixed with other liquids. Put a few drops of water into some gasoline, for instance, and then add a few grains of the dry copper sulphate. Shake this mixture well and you will find that the copper sulphate instantly turns blue. This coloration is caused by the sulphate's absorbtion of water from the gasoline to replace that which was lost in the heating process.

LIQUID CONDUCTORS. Connect two metal plates in a glass of water in series with a small electric bulb and several dry cells. If the water is pure, or contains sugar, the bulb will not light. The addition of salt, however, will make the bulb light. Trying other substances will show that only acids, bases, and salts conduct current. The dissolving of these substances dissociates molecules into negative and positive atoms, known as ions, and the moving streams of ions conduct electricity.



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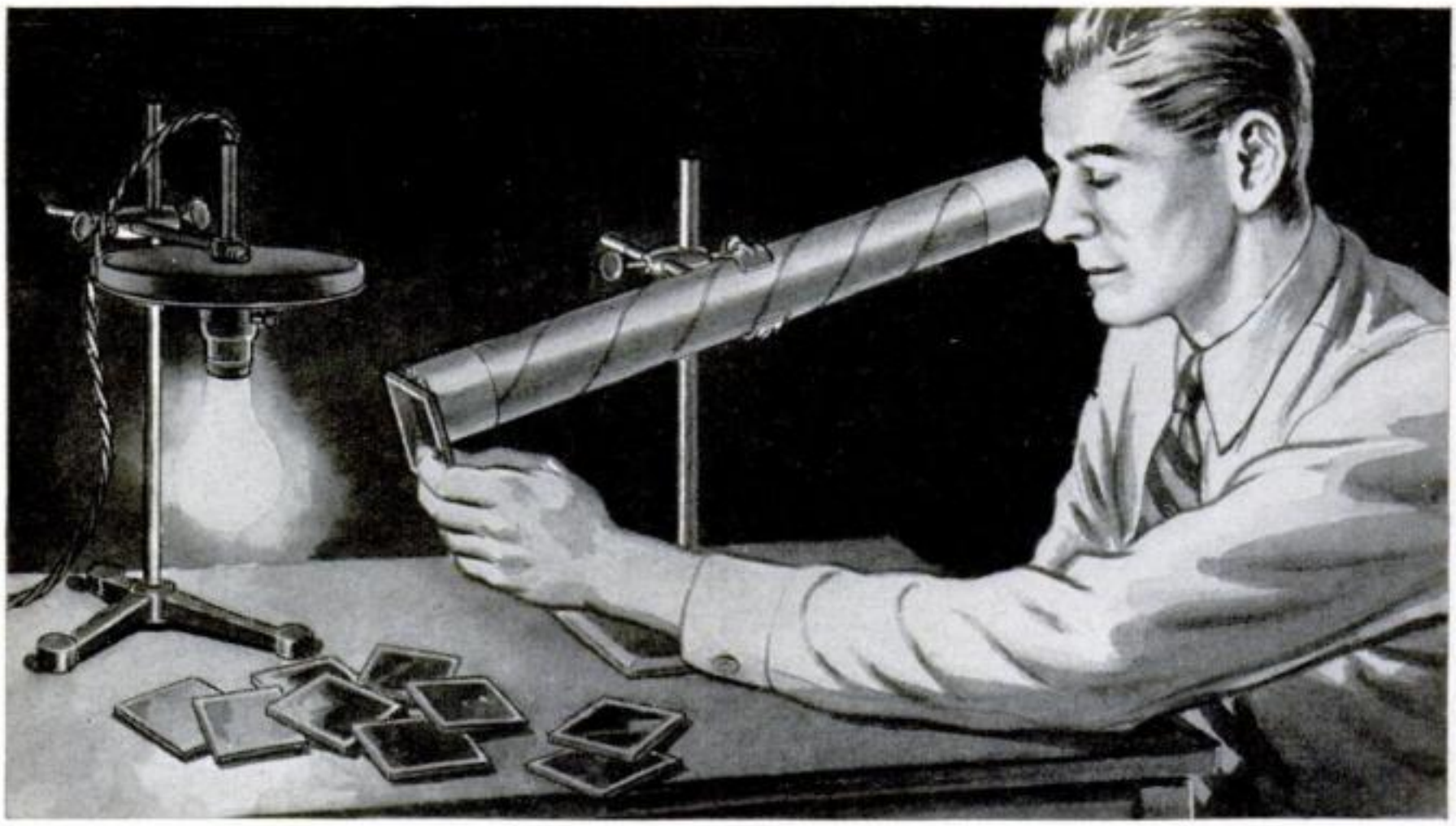
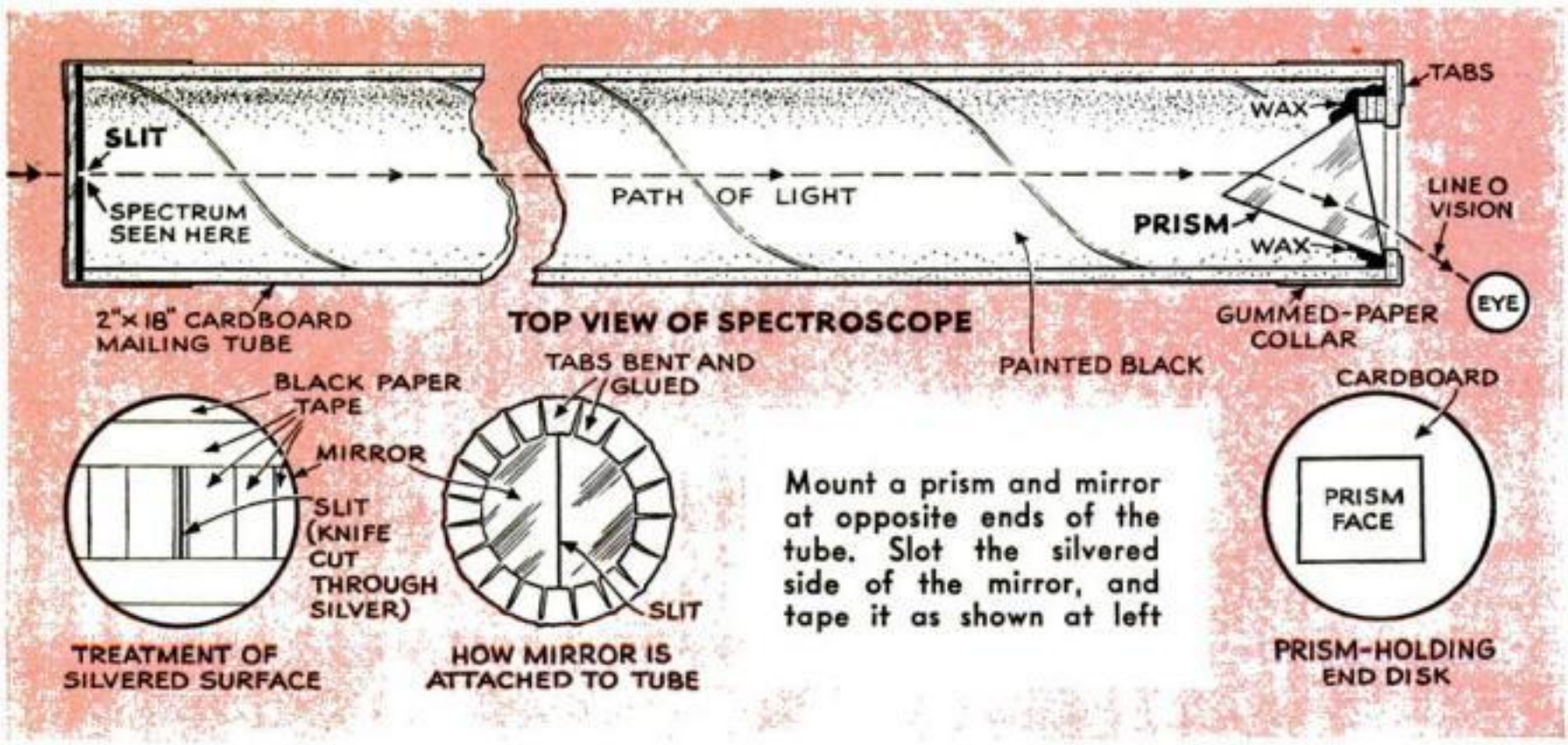


Testing color-filter transmission with a spectroscope made of an inexpensive prism and a mailing tube

Amateur Spectroscope

ANY amateur experimenter will enjoy using the homemade spectroscope shown here. A cheap equilateral prism, costing about $1.50, is all that need be bought. An 18-inch mailing tube, blackened inside, forms the body. Chip a small mirror to fit the tube, and draw a line with a sharp knife through the silvering. Then, with black paper tape, cover all but a half inch or so of the slit to obliterate pinholes. Glued tabs attach the mirror disk, with the unsilvered side out, to one end of the mailing tube as shown. For the opposite end, cut a disk of heavy cardboard, with a window a little smaller than one prism face. Block up one prism edge with a few thicknesses of cardboard, and attach the prism with sealing wax. Fix the disk in place with tabs, and the instrument is finished. For use, point the tube at the sky, a cloud, an opal electric light bulb, or a burner flame. Chemical salts dropped in a flame will exhibit characteristic lines. Practice shows how best to mount the tube, with slit horizontal or vertical, and any standard text will suggest interesting experiments.



HW 508

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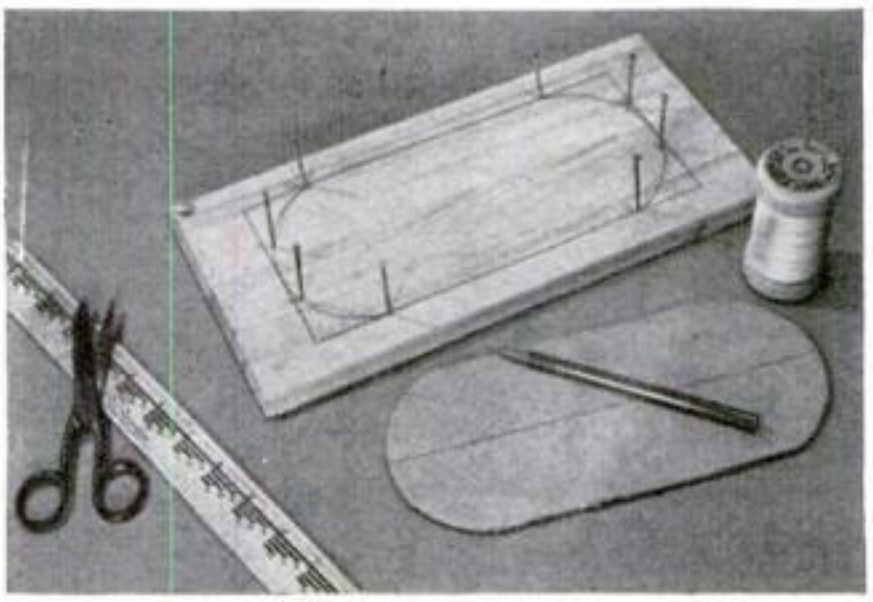
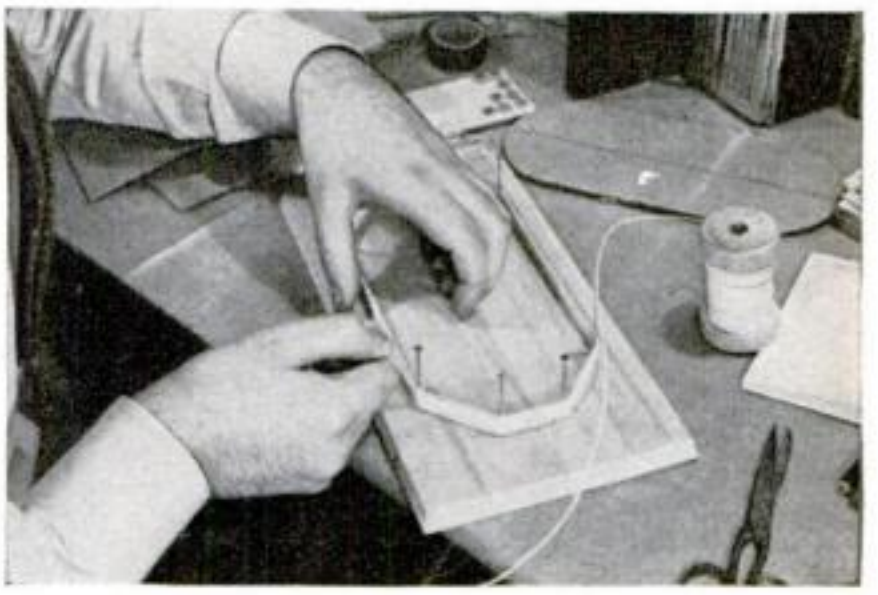
Servicing Your Radio—PART 9

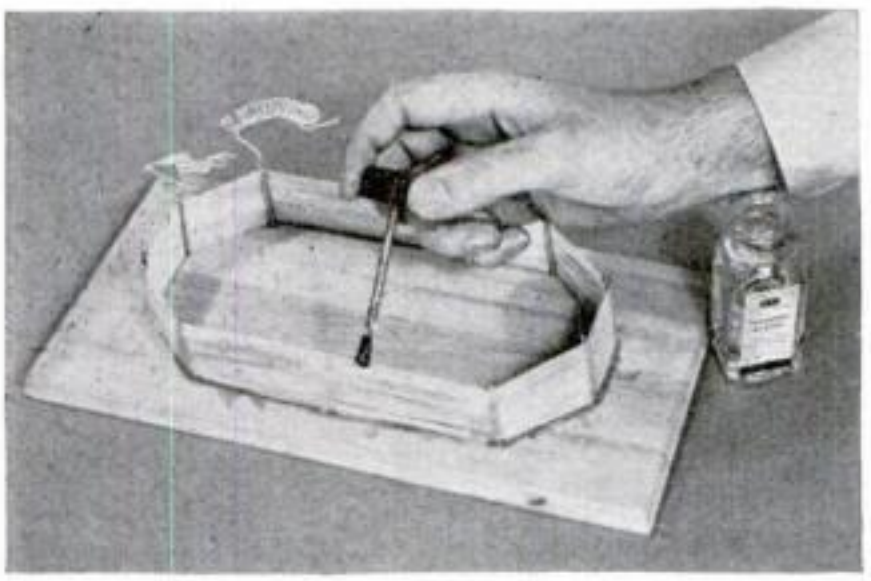
COST and utility make it well worth your time to build your own loop antenna to modernize your old radio and get rid of unsightly tangled wire strung along the floor or hanging out the window. The cost is but a few cents, very little time is needed, and you can design the new antenna to fit your individual cabinet. The photographs below show the materials that are needed and also the step-by-step construction.



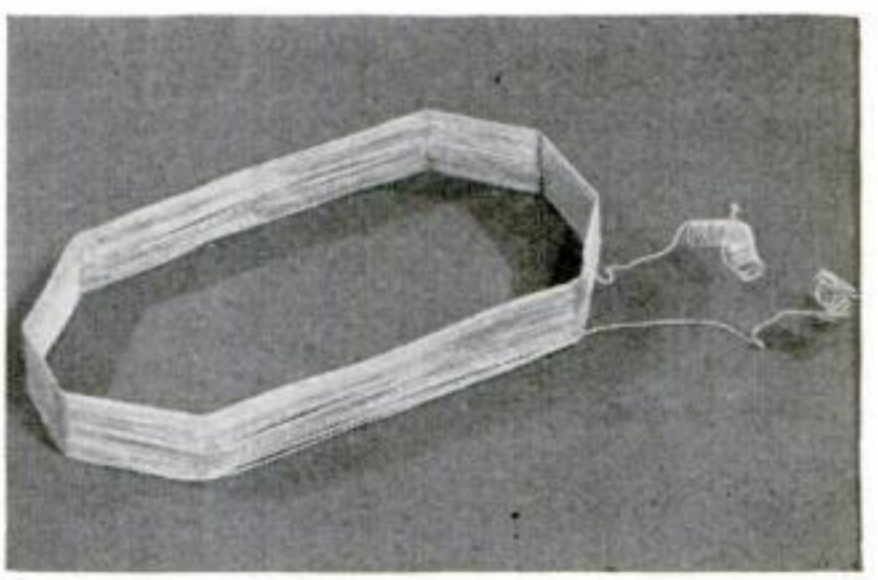
1 Cut a cardboard template about three fourths the size of the back radio cover or opening, lay the template on a board, and around it drive eight 2" nails or pegs. The one here is 4" by 9"



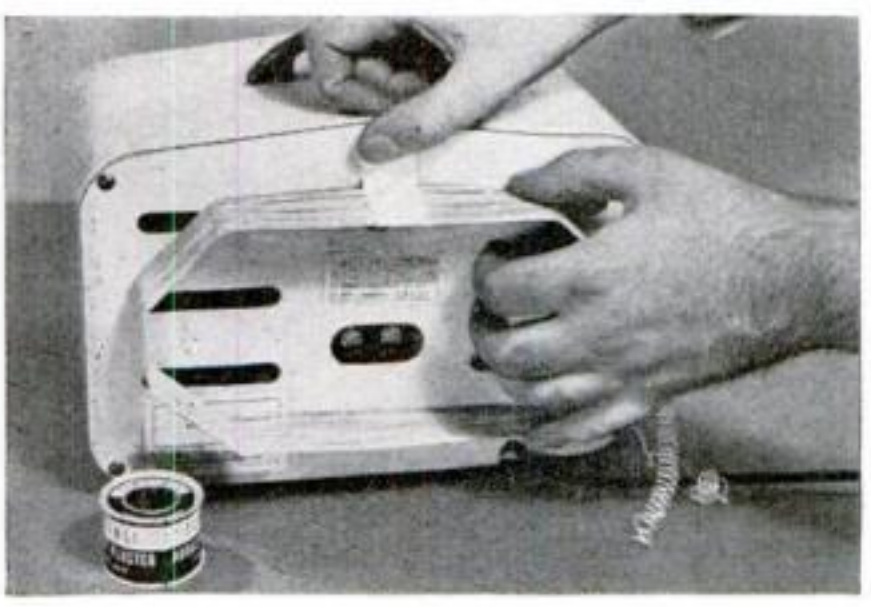
2 Remove the cardboard, and wind either No. 24 or No. 26 double-cotton covered wire around the nails in the form. Approximately 50 turns will be needed. Wind the wire evenly and tight



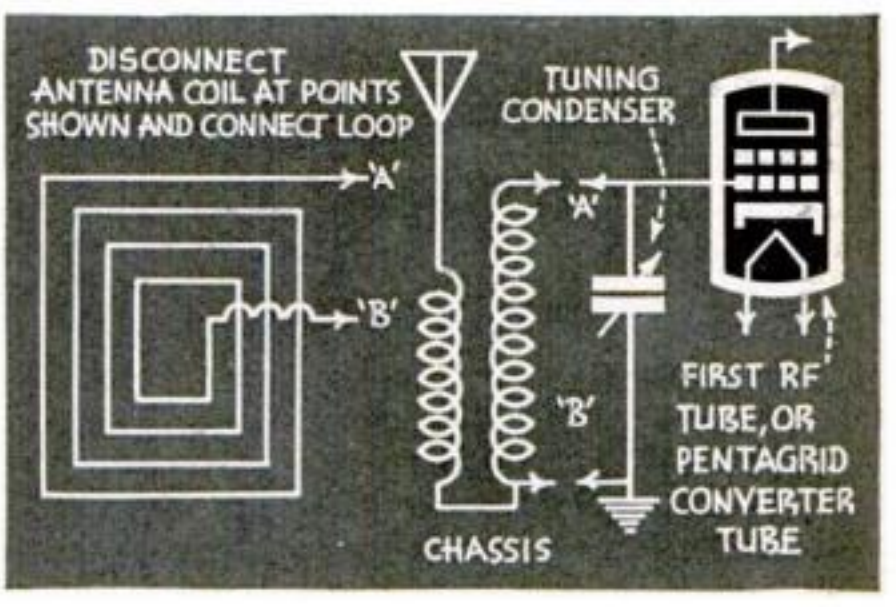
3 At the sides, carefully drive in two more nails to stretch the windings; then apply with a brush a special liquid dope solution carried by radio stores. This sticks the windings together



4 When this dope solution has dried so that the wires will not fall apart during handling of the loop, the nails are drawn from the base. The antenna can then be lifted off for installation



5 Adhesive tape or glued paper holds the loop to the back cover of the radio cabinet or suspends it from the top of the back opening. The antenna is light enough to need no other support



6 To use the loop, disconnect the old antenna coil, as shown. A few turns of the loop may be removed one at a time if needed to balance the trimmer condenser on the ganged tuning condensers

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Compact Radio-Tube Tester

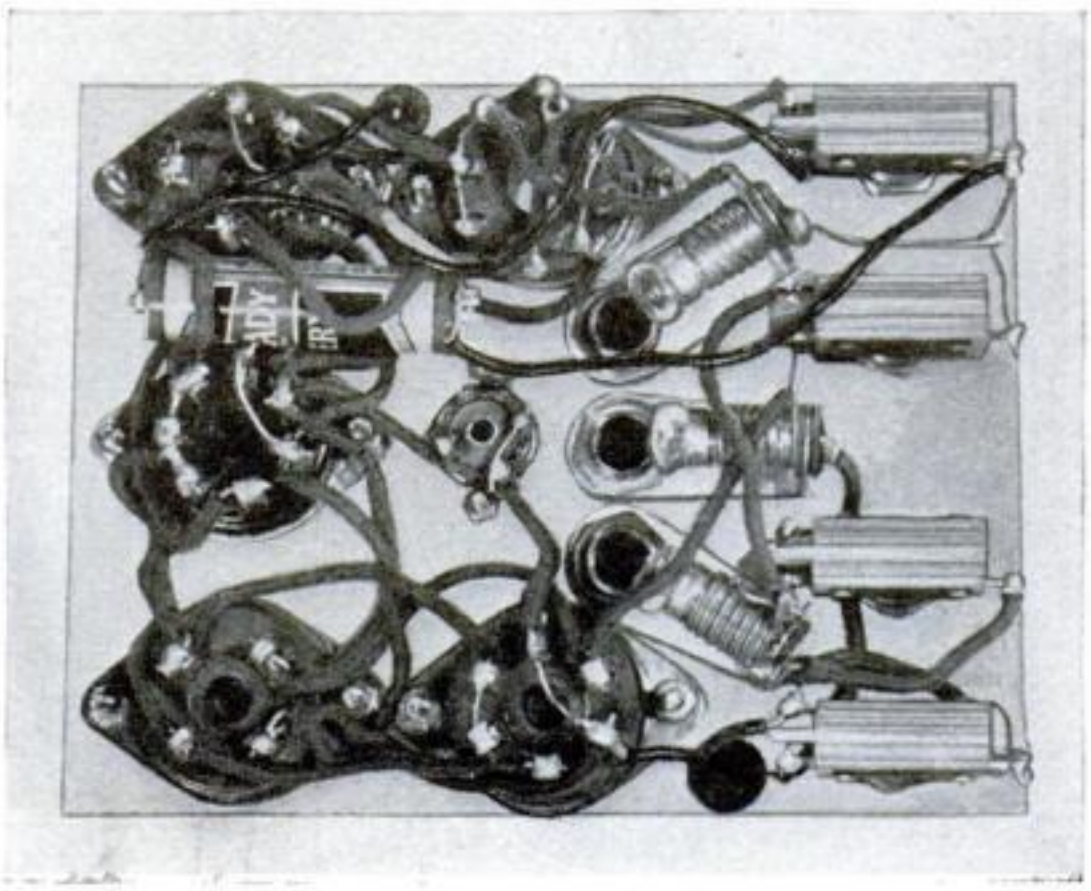
BATTERY-OPERATED UNIT BUILT FOR SIX TYPES OF PRONGS

One of the eight-prong tubes is being fitted into its socket above. The panel has sockets for tubes with four to eight prongs and for the seven-prong miniature

Leather covering makes a handsome carrying case

Slipped into a brief case, as at right, this little unit leaves room for a battery and other accessories

At left, below, top of the panel with the 4.5-volt "C" battery connected. At bottom right is shown wiring, small battery, and flashlight bulbs on the underside



HW 510

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By ARTHUR C. MILLER

THIS tube tester is compact enough for the serviceman's brief case or tool box and simple enough for the radio owner who does his own servicing. It will handle 80 percent of all tubes made, and, with slight alterations, can be adapted for others. All materials are readily available—it employs, for instance, no meters since they are on the priority lists—and many of the parts may be salvaged from the junk box.

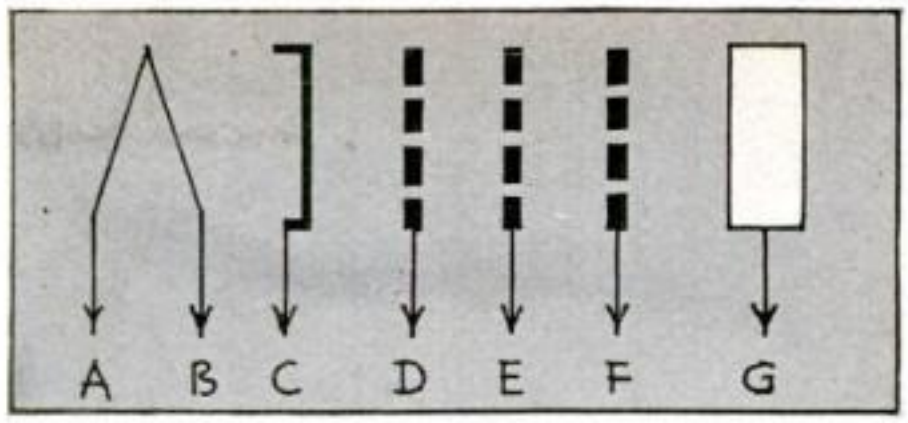
All four-prong to eight-prong tubes for battery, AC, or DC can be handled, and a socket is included for the new miniature seven-prong tube. The device will also test heaters and filaments, and will reveal shorts between elements inside a tube. A loktal-type tube socket can be added by enlarging the case.

No previous adjustment is necessary to test 1.5 and 2-volt DC tubes, 2.5 and 5-volt AC tubes, 6.3, 12.6, 25, 35, and 50-volt AC-DC tubes, or 117-volt heaters and filaments. A tube is placed in the proper socket, and the switch flipped. If it is good, the center jewel reflector lights; if burned out, the reflector remains dark.

Shorts can be detected between the plate of a tube and suppressor and either the screen grid or control grid, between the screen grid and control grid, or between the control grid and cathode or filament. Through operation of three toggle switches, these shorts illuminate the jewel reflector on either the left or right side.

The panel measures 4½" by 5¾", and may be of metal or pressed wood. Five large holes and a smaller one are drilled for tube sockets, three holes for jewel reflectors, and four for toggle switches.

Wiring instructions are given in detail in the diagram below. The grid-cap and plate connections on each socket are wired together, as are the screens and suppressors, and the cathodes and one side of the heater of each tube. Connections for testing shorts within a tube are shorted in and out of the circuit by toggle switches.

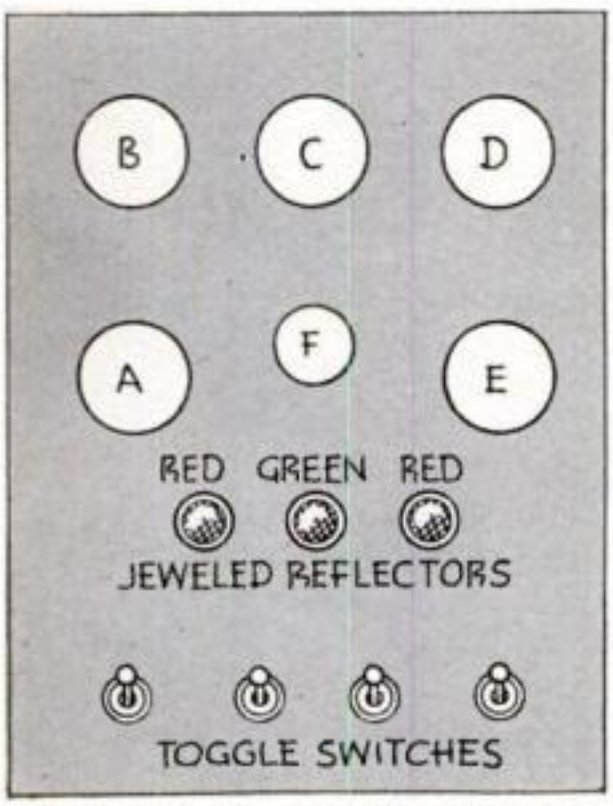


Shorts may be tested between plate and suppressor, G and F above; suppressor and either screen grid, E, or control grid, D; screen and control grid, E and D; control grid and cathode, D and C; and control grid and filament, D and A

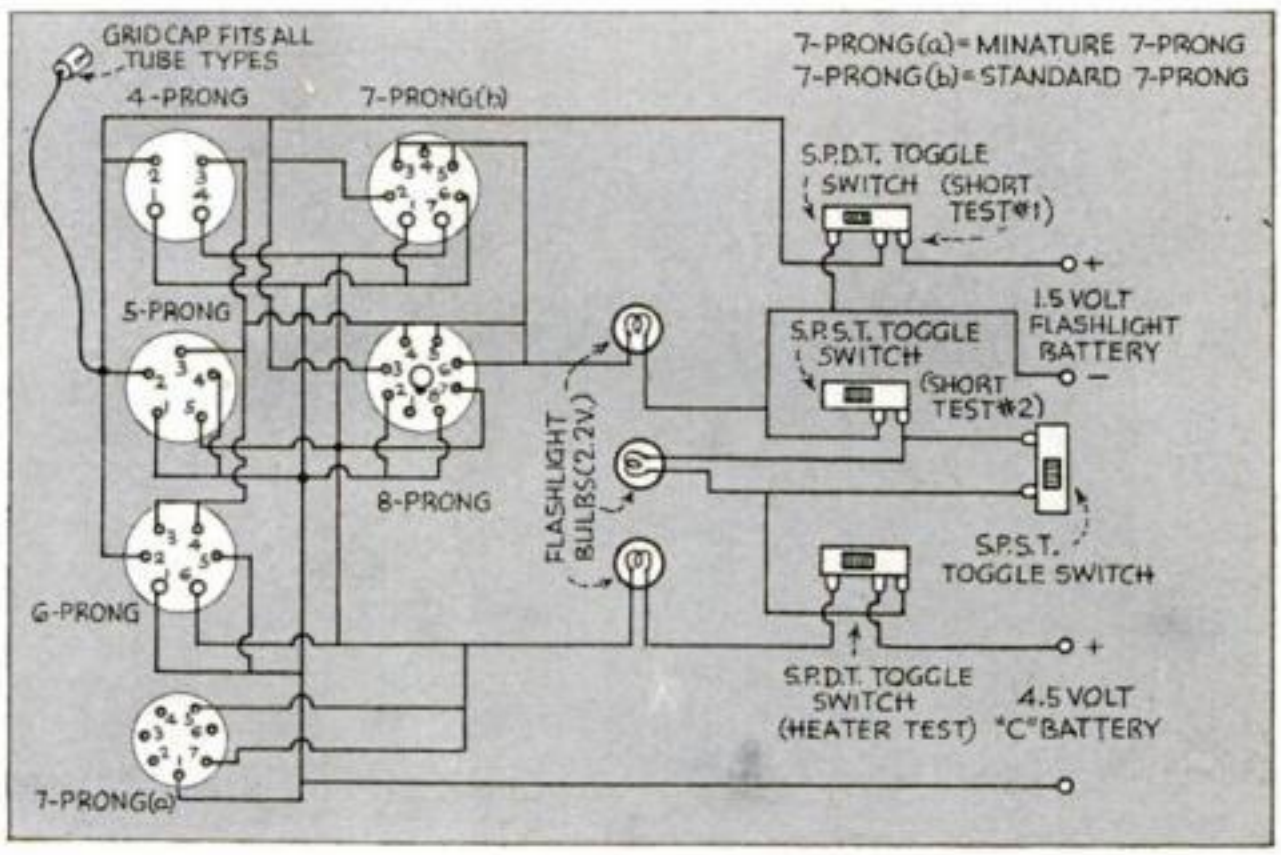
The source of current is a 4.5-volt "C" battery, but a small pen-type 1.5-volt battery is needed for testing shorts between the plate and suppressor or the control grid and screen of a tube. This 1.5-volt battery is installed under the chassis and supported by its own wiring.

The three flashlight bulbs used are the type made for small flashlights, and are rated at 2.2 volts. Do not use any other kind, for no other will work. Some bulbs might even blow out the filaments of a 1.5 or 2-volt battery tube.

A special leather-covered case, 2⅛" by 5" by 6¼", may be purchased, or a case may be built from small pieces of wood glued together. If desired, cardboard may be used for the top and bottom.



Sockets in the panel layout are: A, 8-prong; B, 5; C, 7; D, 4; E, 6; and F, 7-prong miniature



Wiring may be done in one evening by following this complete diagram

HW 511

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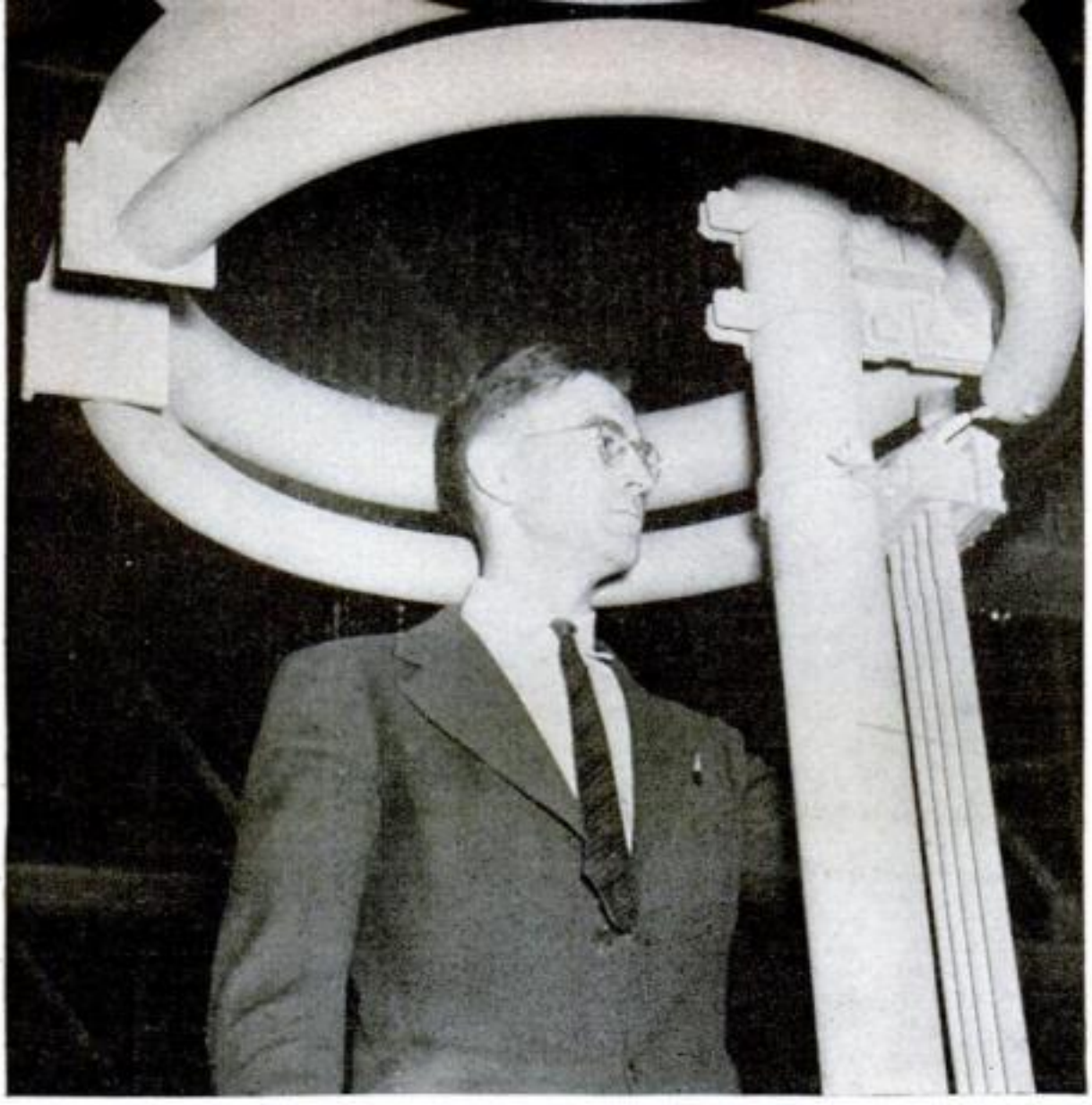
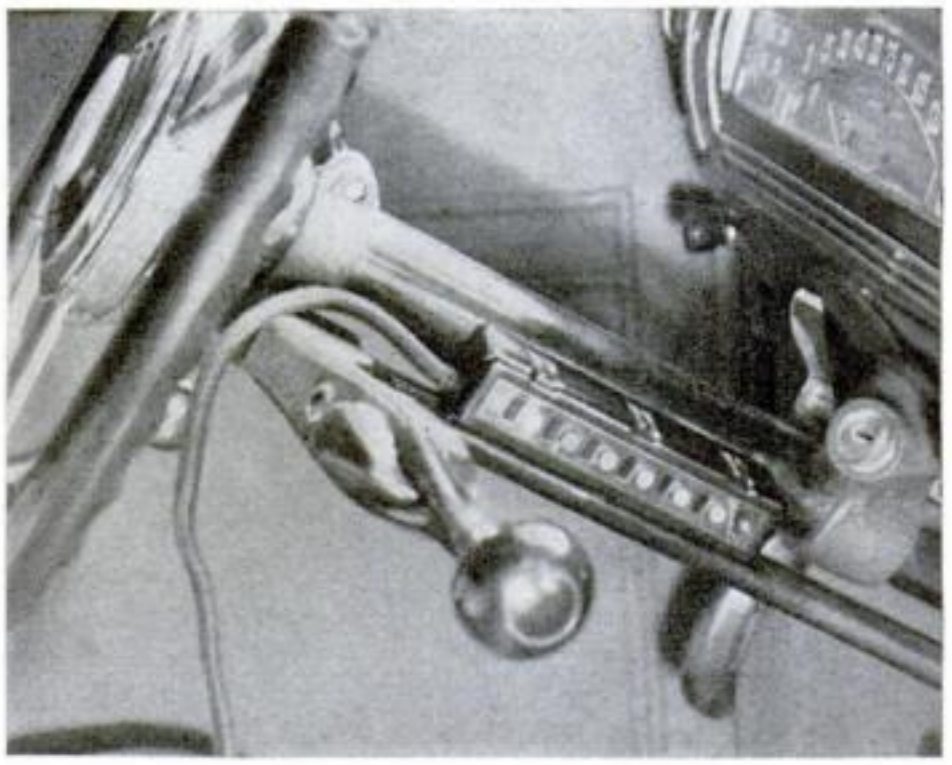
Radio Ideas



FM ANTENNA DESIGN takes a big step toward simplification with the circular type shown at left, which was developed by General Electric engineers for ultra-high-frequency transmission. The new antenna is said to have the advantage of radiating a substantially uniform energy in all directions without employing a complex and comparatively costly structure. It is sturdy enough to be mounted directly on the roof of a truck in place of a long vertical antenna of the whip type in common use.

PUSH-BUTTON ELECTRIC TUNING is possible on any six-volt receiver with the installation of the new tuning unit in the photo at right. A choice of five stations is brought in automatically, while a sixth button enables manual tuning. The button unit, in a 1 3/16" by 1¼" by 5⅛" black plastic case, is clamped to the steering post of your auto within easy reach of the driver, while the unit containing the relay mechanism is housed in a rustproof metal case attached to the side of the receiver. Trimmer condensers are provided in the set-up for permanent tuning to the five broadcasting stations selected for push-button tuning control.



INSULATING ENAMEL has been developed for use on all types of coils and motor windings to provide protection from the corrosive action of both acids and alkalis. A single application coats the part with a tough, red, oilproof and waterproof film five mils in thickness and having a dielectric strength said to exceed 850 volts per mil. The enamel may be used on radio coils, control coils, solenoid coils, and the like, as an inside or outside protective coating for motor windings and commutator end bars, or on other electrical units where a high-gloss, bright-red finish is found to be both desirable and practical.

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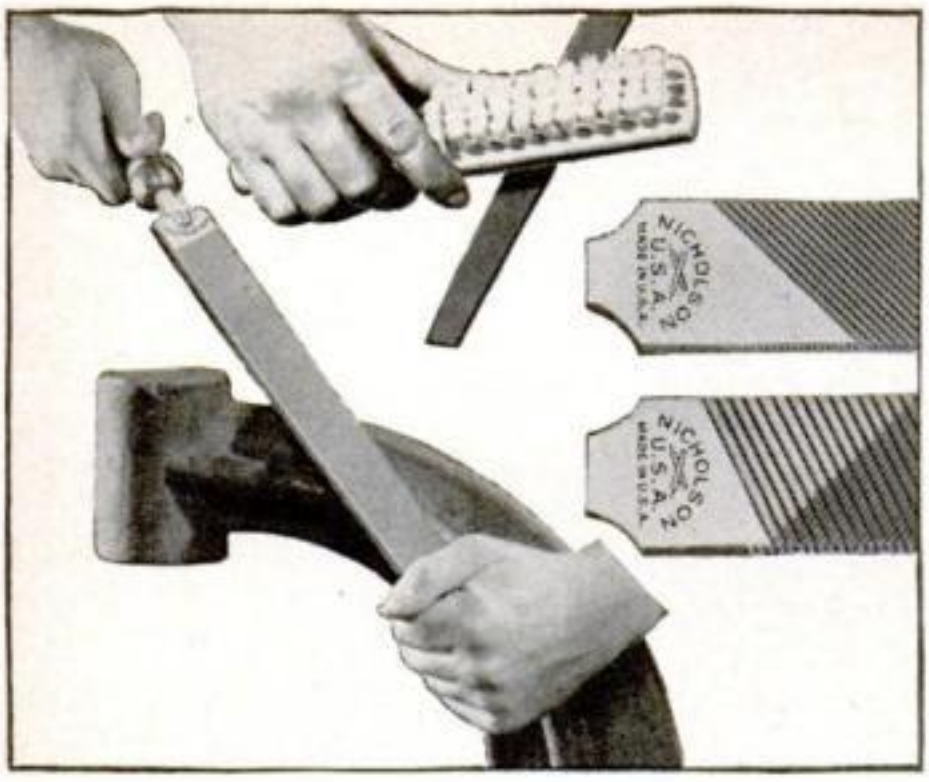

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- Don't stack files against, or lay them on top of, one another.
- Keep files dry so rust will not corrode their cutting edges.
- Keep files clean of filings. After every few strokes, tap file on wooden object to loosen chips. Brush file frequently with file brush or card; and always before putting file away.

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Celestial Yardstick

(Continued from page 119)

the asteroid was under almost constant observation by 32 telescopes at 25 observatories throughout the world. The net result was to establish the distance and position of Eros and so set up a satisfactory base line.

Man's knowledge of the sun and the solar system has been growing from antiquity. Apparently the first person to question the belief that the sun was a god, or at least a supernatural being, was the Greek Anaxagoras, who in 434 B. C. suggested that the sun was a ball of fiery metal about the size of Peloponnesus. He was arrested for heresy, and only the eloquence and influence of his friend Pericles saved him.

It is interesting to try to reconstruct Anaxagoras' reasoning. In common with all men of his time, he believed that the earth was flat. He also knew that the height of the sun above the horizon varies with the place of observation. Today we know that this result comes from the curvature of the earth's surface, but Anaxagoras reasoned, quite logically, that this apparent displacement resulted from the sun's nearness. He used this displacement to calculate its distance, and obtained a value of 12,500 miles. It was a marked step forward.

The next great step was taken by Aristarchus of Samos about 200 years later. Aristarchus knew that the earth was round, and that the planets moved in orbits around the sun as a center, and that the moon, shining by reflected sunlight, moved around the earth. He concluded that the sun's distance was at least 14 times greater than that of the moon, or in excess of about 3,000,000 miles.

Although this figure was short by a factor of 20, it remained essentially unchallenged until the latter part of the 17th century, and no result which even approximated the true determination was obtained until Lacaille, in 1752, achieved comparative success with triangulation.

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What Are Plastics Made Of?

(Continued from page 63)

to have proved inferior to the more flexible black walnut, but for grips and handles of pistols and machine guns, and for bayonet mountings, they are entirely suitable. Three parts of the 60-mm. trench-mortar fuse are made of thermosetting plastic, saving a pound of bar aluminum in each projectile. Tests indicate the possibility that laminated plastics may ultimately replace metal for the windshields (cone-shaped points) of 20-mm., 37-mm., and 75-mm. shells. Another possible application is in the elevating and traversing mechanisms of tank guns, perhaps also in the hand wheels of artillery weapons, and in lighter services such as eyepieces for fire-control field glasses and telescopes, protractors, control knobs, etc. For that matter, smokeless powder itself is essentially an extruded cellulose nitrate plastic.

Then there are all those applications which the armed services share with civilian activities, such as safety glass and tire reinforcements in automotive vehicles. A plastic or plasticlike fiber like rayon yarn is usually thought of in connection with pretty girls in stocking and underwear ads, but it is also used for tire cords in fighting planes and motorized artillery, in ropes for towing aerial targets, in army sleeping bags, and as a covering for electric wire. Of the 6,000,000 miles of rayon yarn produced every day by a single company, the American Viscose Corporation, a large proportion goes into war applications.

Every increase in efficiency in shipping, packaging, fabrication, surgery and whatnot is a contribution to ultimate victory. In Western airplane factories, jigs and dies from cast plastics are reported not only to be conserving strategic metals but to have saved between two and three months on the tooling program for the B-17F Flying Fortress. Du Pont offers cellulose acetate for spacers to save metal and speed up milling-machine operations. In the stern tubes of ships, laminated plastics are outwearing lignum vitae, the conventional material. Pipes made of a thermoplastic resin, a quarter the weight of iron, can be welded in two minutes. Plastic surgical windows serve as portholes through which the healing of a bomb wound may be observed, cultures may be obtained for analysis, etc. Wire mesh coated with cellulose acetate, used as a flexible "health glass" before the war because it transmits ultraviolet light, is found to resist the shock of a

(Continued on page 220)

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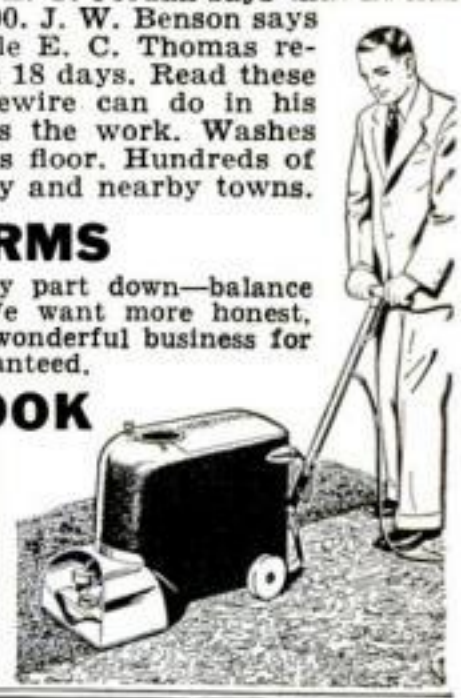

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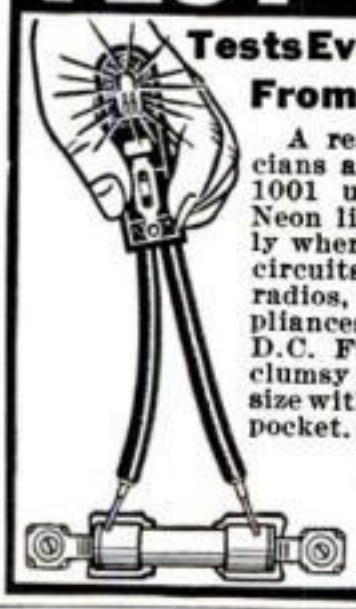

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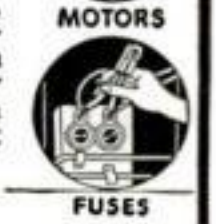

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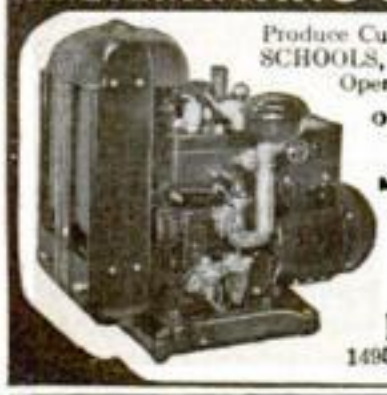

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What Are Plastics Made Of?

(Continued from page 218)

150-pound bomb exploding six feet away. There seems to be no end to the actual and pending applications of plastics in connection with the war effort.

Not the least important is the possibility of saving a moderate amount of rubber at a time when every ounce counts. Rubber-like plastics include some of the polyvinyl alcohols and ethyl cellulose, the latter made from cotton linters or wood pulp, common salt, and alcohol. Another type includes synthetic resins of the vinyl acetal group, used as an interlayer in safety glass, but now also available for waterproofing service raincoats, hospital sheeting, and the like. In a single Army raincoat this plastic replaces one and three quarter pounds of rubber—17,500,000 pounds for an army of 10,000,000 men. A one-to-one composition of ethyl cellulose and castor oil makes washers, gaskets, rollers, gloves, galoshes, electrical tape, gas masks, etc., just about as good, for their particular purposes, as articles made of rubber.

In many industrial applications, rubber-like plastics are doing a better job than rubber itself. Polyvinyl alcohol, marketed under the trade name Resistoflex, is being used to replace rubber and metal hose in automatic machinery for making radio tubes. Water dissolves it, but it will carry about anything else, and stay on the job longer than natural rubber. In many mechanical applications it is likewise outlasting rubber and metal.

Even though plastic materials like ethyl cellulose and polyvinyl alcohol lack the bounce and elasticity of natural rubber or the better synthetics like Neoprene, they are forging ahead in the all-important industrial field and in many military and civilian applications. It is estimated that no less than 60,000 tons of rubber have been used annually for purposes where elasticity was incidental.

They talk of plastic chairs with the body molded in one piece, entailing only one assembly operation—the fastening of plastic legs onto the body—and covered with a preformed plastic upholstery fabric, slide-fastened and instantaneously removable for cleaning. And of molded resinous-pulp refrigerators; plastic household appliances —vacuum cleaners, juice extractors, washing machines—of plastic-plywood boats and airplanes, and much else. Many of these we had before the war. They will reappear in better, cheaper, and more beautiful forms, with other devices as yet only dreamed of.

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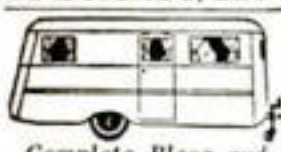

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Wings of Victory

(Continued from page 83)

vertical fins which cut down speed. It also, in effect, makes the airplane practically torqueless, therefore, more maneuverable.

Putting the pilot and armament in a separate nacelle or streamlined pod in the center of the wing offers several advantages. In the first place, the accuracy of fire from the four .50 caliber machine guns and single 37-mm. cannon is enhanced by the fact that they are not mounted over or in the same line with any vibrating power plant. Grouped as closely together as they are, the guns' fire pattern is concentrated over a small area and has the effect of a combination meat grinder and buzz saw when it gets the range for even a short burst. The small nacelle can be sealed airtight and supercharged without the mechanical difficulty encountered in the ordinary full-fuselage designs. This makes it one of the top high-altitude jobs of all time.

The P-51 is our latest baby, so good that even the British have gotten enthusiastic about it. It is a change-of-pace airplane. The hell that the U. S.-built Flying Fortresses have raised in the "out of sight" fighting levels have forced the Axis to build such monstrosities as the Focke-Wulf 190, the new Messerschmitt 210, and the like. Suddenly the Mustang arrives, capable of making great speed within a shadow of the ground. Only the luckiest kind of a shot can bring one down.

The human ear can pick up the sound of this low-flying infant only when it is overhead. One of the forerunners of the Dieppe raid was said to be a lone P-51 that picked itself a deep, rolling Channel swell and, skidding all the way across the Channel in its trough, hopped over the sea wall, flew between two buildings, heaved a salvo of delayed-action bombs into the largest radio installation on the occupied French coast, and dashed back before the German alarm system had a chance to function.

It is a lot harder to get a low-altitude ship to go fast than one built to operate in the substratosphere. The thin air in the higher levels offers little resistance to the wings, and as long as there is enough surface and enough power, the airplane can move at quite a clip, simply because there is little to hold it back.

At the lower levels, while the lifting characteristic of wings is far more efficient, the air offers far greater resistance. At high speeds, it tends to "pile up" just behind the highest point of wing curve. At speeds approaching 500 m.p.h. on most con-

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ventional wing curves, the air actually breaks its "laminar flow" and lift-destroying turbulences occur in the boundary layer. The Mustang is winged with a special airfoil whose profile permits the smooth flow of air at all speeds.

Some of the aforementioned critics of U. S. tactics seized upon the scant early information on the P-51 to criticize the fact that it had poor high-altitude performance. To begin with, the P-51 has no high-altitude performance—none was built into it. Every line, provision, and device in the ship was built for phenomenal speeds at low levels. An early critic stated that the new German FW-190 that appeared at about the same time would probably outrange and outfight the Mustang if it tried to come up and do combat at the 190's most efficient level of 22,000 feet.

In the first place, the P-51 would probably never seek combat with a 190. It is not built to do that kind of a job. Secondly, the P-51 could not get to 22,000 feet with anything less than a strato-balloon. *But*—if the 190 had the bad judgment to come down to the lower levels, it would be as helpless as a fish out of water. Consider the weight side of it. The 190 would be running around with the weight of an unused supercharger, oxygen system, the weight and drag of a thick, high-altitude wing, 40 percent of which would be surplus at low levels, and its pilot wrapped up in a teddy-bear suit. Its engine, geared to produce its top power in thin air, would be putting out less than 60 percent of its power. Compare this flounderer with the cocky kid flying in his shirt sleeves in a comfortable low-altitude job, with only the things he needs surrounding him; his engine putting out every rev it can and a wing custom-built to keep him flying at his own particular level.

Fit mate to the Lightning, the P-47, Republic's Thunderbolt, is our newest bid for high-altitude supremacy. As yet unproved in battle, we have only characteristic comparison to check it against. We know that a type is needed that can stand and fight at high altitudes, that has range enough to meet and intercept high-flying, low-range aircraft, that will have speed and climb to spare and have one prime virtue missing in most high-altitude craft—*gunpower*. So far, no ship at any class or altitude has demonstrated the horizontal speed of the Thunderbolt. Its rate of climb is phenomenal, its gunpower burst equal to the impact of a five-ton truck at 60 m.p.h. The fact that the two latest-type fighter craft operate at opposite levels indicates the justification of the former U. S. theory for the conduct of

(Continued on page 224)

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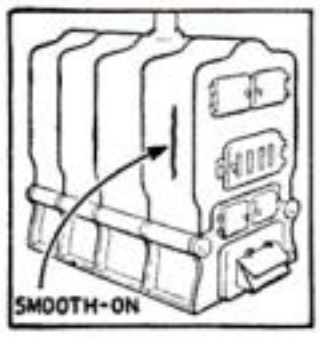

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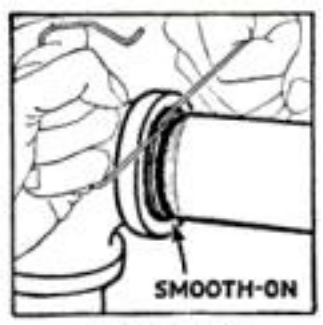

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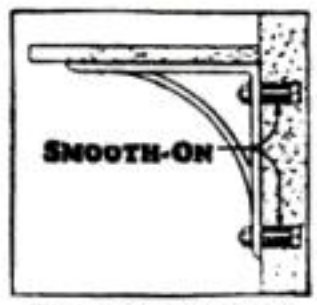

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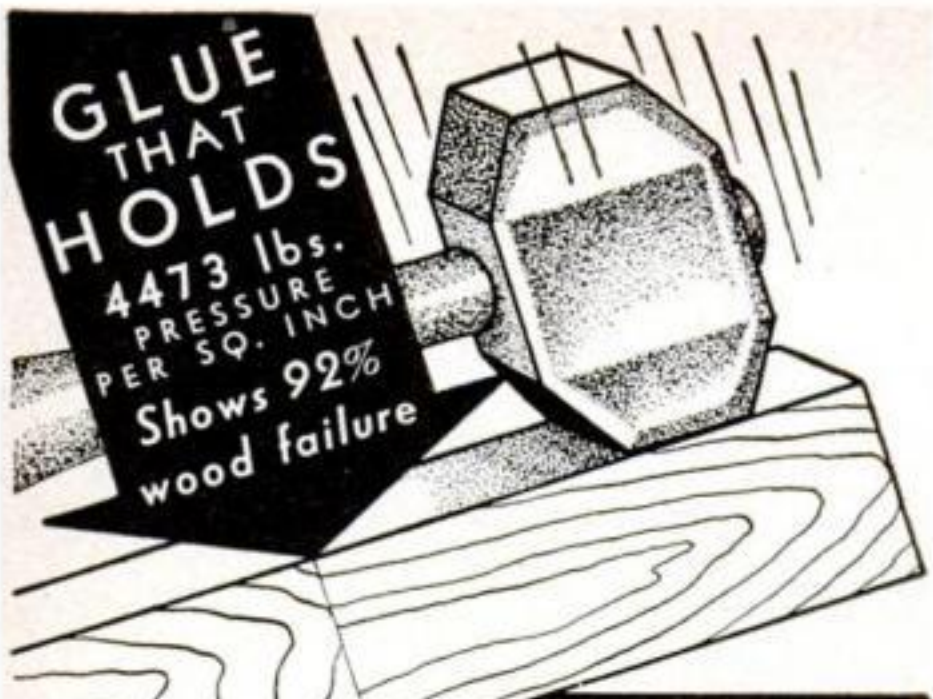

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Wings of Victory

(Continued from page 223)

war, the change of pace that requires the enemy to keep a great diversity of equipment in production.

The A Class—attack and dive bombers—are the group that stands between fighters and bombers. We have concentrated on two such types. The A-20, known as the Douglas "Boston" in its day-raider conversion and the Havoc as a night fighter, is basically an attack bomber. It is built to operate at near pursuit speeds, pack a lot of gun-power forward and enough maneuverability to take on any single-seater built. The big thing that was asked of the A-20 design was range of speed—the ability to cruise at near-stalling speed for hours on end, hunting out troop concentrations, convoys, and weak spots. Once they are spotted, the A-20 hauls up its flap, opens the gun, and punishes the objective with a murderous fire-cluster forward, baptizes it with bombs as it goes over, and then dusts it off with the rear gun as it speeds by.

The Boston's record in daylight sweeps over the continent is equaled only by the African record. A thoroughly disorganized, busted-up troop, supply, or tank movement is termed *Bostonized* no matter how the action happened. The A-20's wide range of speed and favorable landing characteristics promoted by an awninglike flap and tricycle landing gear have made the night version, the Havoc, with double forward-firing power, ideal for prowling around German flying fields in northern France, waiting for some unfortunate bomber to try to take off. At the precise moment when the bomber begins to be air-borne, the Havoc dives in and gives it a single burst, frequently causing the ship to explode with its entire destructive load aboard.

The manufacturer's designation for this type is the DB-7. It is the first one of its type to be able to out-Stuka the Stuka and fight anything that came against it.

The other U. S. member of the A class, other than the Douglas "Dauntless," which was borrowed from the Navy as a short-range stop-gap, is the A-31, the Vultee Vengeance. Originally programmed for exclusive British production, this design incorporates all the virtues of the former types of single-engined dive bomber, stamina plus good control of diving direction; and speed, plus enough gun-power for its own defense.

The original Stuka, the Junkers JU-87 is an outstanding example of a one-purpose airplane carried to a great extreme. A

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capable dive bomber, it was a dead duck if caught by anything that could really fight. The Germans tried to counter this frank tactical mistake with imitations of the DB-7—light, twin engined bombers equipped with diving brakes. While these were fairly successful, they gave up some of the essential virtues of the JU-87: economical operation, great maneuverability close to the ground, steep diving angle, and great variety of dive pattern.

Combining our own U. S. dive-bomber experience with some of the German ideas plus the British experiences, the Vengeance was built. In the first place, the Vengeance is plentifully armed. Its total gun power is that of the average single seater. It carries its bombs internally, permitting at-will bomb selection and higher speeds. The average enemy dive bomber carries most of its missiles externally, and the loads, usually hung under the wings, must be symmetrically released to keep the ship under good control.

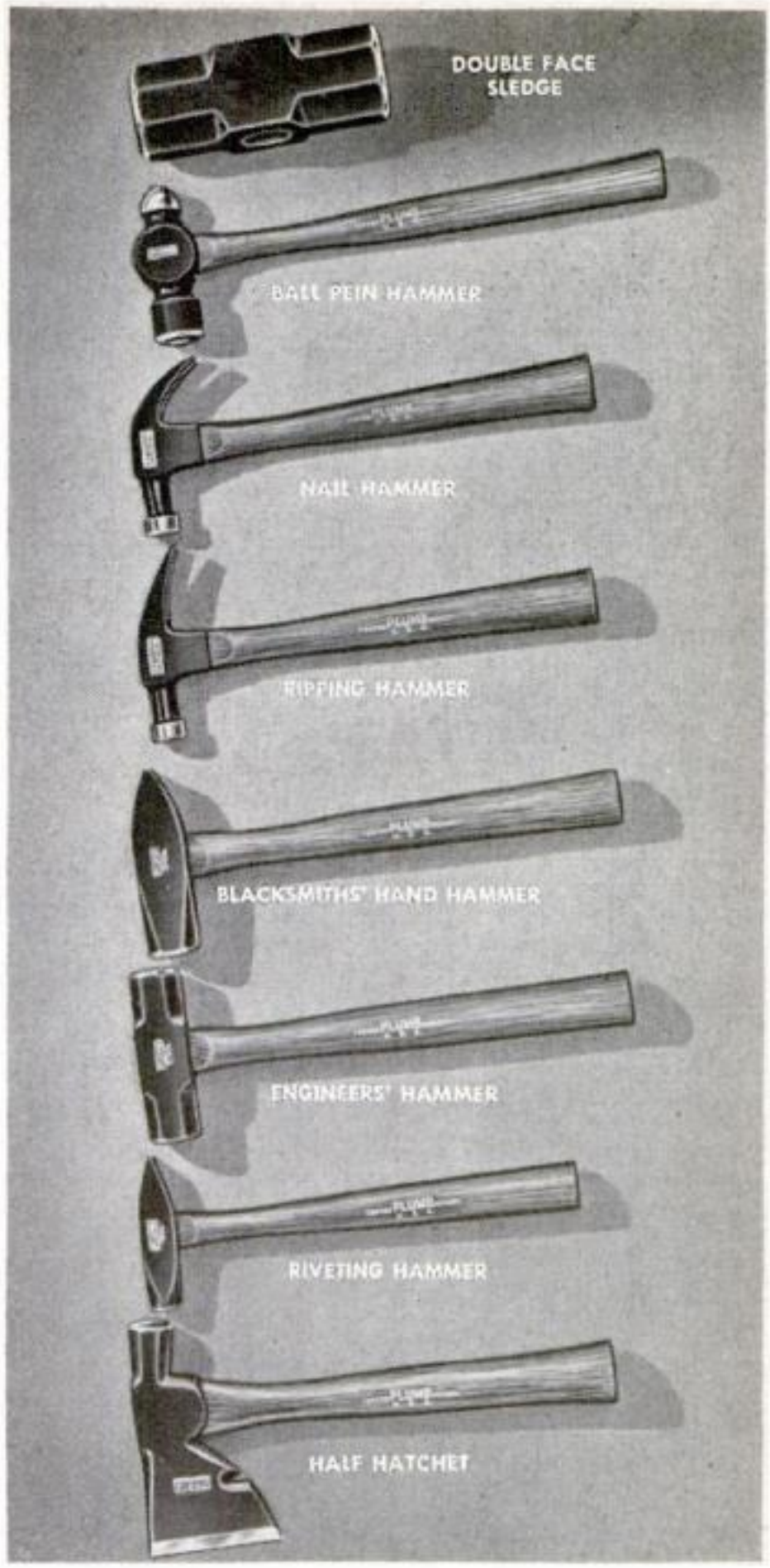
Our two current medium bombers stack up well against their basic requirements, and the basic requirements indicate that the Air Staff were better guessers than average in this class.

In the B-25, they asked for a medium-weight bomber that could operate out of short, unprepared fields under all conditions. It required mid-altitude performance for middle distances under fire through hostile country. Therefore, a good part of the useful load had to be invested in armament. While the first submarine sinking in the Atlantic and General Doolittle's raid on Tokio may have been spectacular demonstrations of the B-25's versatility as a combat bomber, General Ralph Royce's raids on Japanese emplacements in the Philippines showed the ship to its best advantage. Slipping into hastily prepared advance bases, so quickly arranged that the enemy hasn't found them yet, Royce punished them soundly from both low and medium altitudes and was out of range before the yellow brethren could gather their wits.

This demand for "get up and go" is amply supplied by the Mitchell, as the type has been named. In Australia and the Archipelago it has been flown from beaches and crudely hacked-out fighter-advanced posts. Its heavy armament allows it to operate without fighter support and frequently without any advance pursuit co-operation. In other words, a gang of B-25's is capable of parking anywhere midway between the enemy and a supply base and operating as long as the fuel, ammunition, and supplies flow in at a tolerable rate.

The Martin Marauder, the B-26, was one

(Continued on page 226)



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Wings of Victory

(Continued from page 225)

of the most spectacular guesses in air history. There were some in the Air Force that would have bet heavy odds that Peyton Magruder's overgrown closed-course racer would wind up a prototype and a number. Like the bumble bee, one could prove on a slide rule that it was incapable of taxiing, much less flying. Magruder, young, lithe, handsome nonconformist, kicked half of the accepted theories for bomber construction out of the window when the Army asked for a terrifically fast short-range bomber that could interchange weight for range at will.

Several basic sketches were presented at a staff meeting at Martin's. Some were improvements on the existing Marylands and revised Baltimores, others were radical changes. The most radical was the Magruder suggestion. Glenn Martin took one quick look at the B-26 and selected it. Some wondered if the boss was slipping.

No one, thus far, has doped out a logical way of attacking the B-26. Hauling nearly as much armament in a small area as a heavy bomber, carrying nearly as much weight as a Fortress (a shorter distance), most fighter craft would have to work hard to catch this ship and then might find they had a bear by the tail. With plenty of guns forward, top, tail, at its sides, and below, it resembles the B-17 in the completeness of its gun-arc coverage.

At Midway and off the Aleutians, they have been "doubling in brass" as torpedo planes. The rack for torpedoes has been built into all existing models. It can serve interchangeably as heavy-weight, short-range bomber with its normal tanks; middle-weight, mid-range bomber with a fair load; or it can, by installing self-sealing tanks in as many of its four bomb bays as needed, haul a bigger torpedo farther than anything except a submarine or a destroyer.

We can stick our chests out the farthest in the long-range bomber class. First, our B-24, the Consolidated Liberator. Having the intestinal fortitude to adopt a radical wing curve is something even Japan's desperate ministry dared not do. The Davis wing that mounts its long, tapered span, permits greater lift from its area than any other yet devised. There is a lot that cannot be said now about this wing, but the fact that the B-24 is the backbone of our air-freight system indicates that it is the hottest long-range hauling machine in the history of transportation. Like the P-40 it is a foot-in-the-door airplane. Its tricycle

landing gear allows it to get in and out of places formerly reserved for light, twin-engined transports of the 9,000-pound class.

Alongside the Hurricane and the Spitfire, the B-17 will probably remain among the greatest tactical guesses in history. The self-sufficient bomber was a pet dream of General Arnold for a decade. The original proposition was to build an airplane that could strike hard or sink a battleship half way out in the Atlantic, disperse landing efforts off the bulge of South America, or hop off the bastions of Hawaii or the stations in the Philippines to meet an enemy fleet anywhere in the Pacific. More important, it was determined even then that a bomber, trying to get to a vital area in the heart of an enemy country, would have to fight off wave after wave of attackers. This meant that its penetration was limited not by the amount of fuel but by the defensive ammunition it could carry.

Load-hauling, high-climbing aircraft had been built before, but this ship had a specific job to do—precision bombing at long range at high altitude. It could not afford to have its radius of action limited by the range of escort aircraft. It had to proceed to a distant target *alone*. The U. S. Army bombsight would permit spot effectiveness of bombing, so too much weight was not necessary. This was no pattern-bombing craft, satisfied to slip in at night and obliterate an area; the global war for which this was built required that it be able to hit one ship, one block, or one house from a height out of range of any attacker.

How has the General Staff guessed? Look at the pattern of its result in every theater of war. To begin with, what other nation's equipment is serving wherever fighting is taking place? Obviously, our equipment is the only group built to fight a global war. In each class, two types are represented at least—one "foot-in-the-door" airplane to establish advanced bases, feel out the enemy and establish the pattern of action. The others are the knockout types, the ships to come in and deal the telling blows.

Our aircraft have shown up as superior to any, even those of our allies, in one outstanding general characteristic—stamina. Those who foresaw a global war knew that aircraft would have to be dispersed to far places, transferred from one climate to another, live outdoors for the duration and frequently be maintained with the simplest tools or no tools at all.

These are the 11 main types. We will probably see many more added before the conflict is over. Nevertheless, there are experts who expect to see only modifications of these less-than-a-dozen in the fight when the Axis is finally buried.

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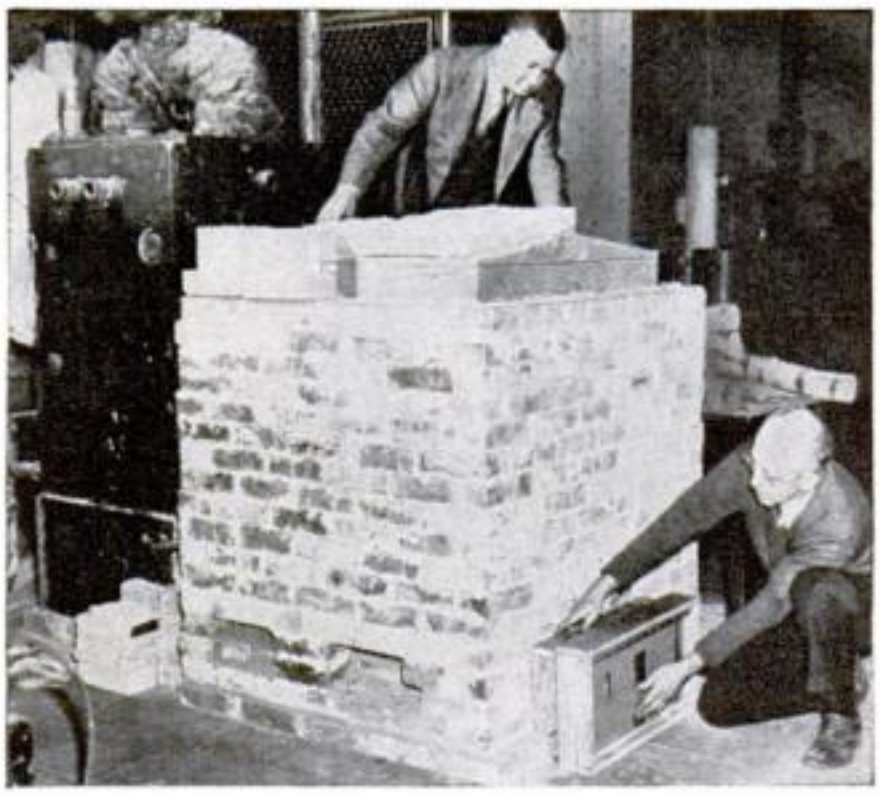
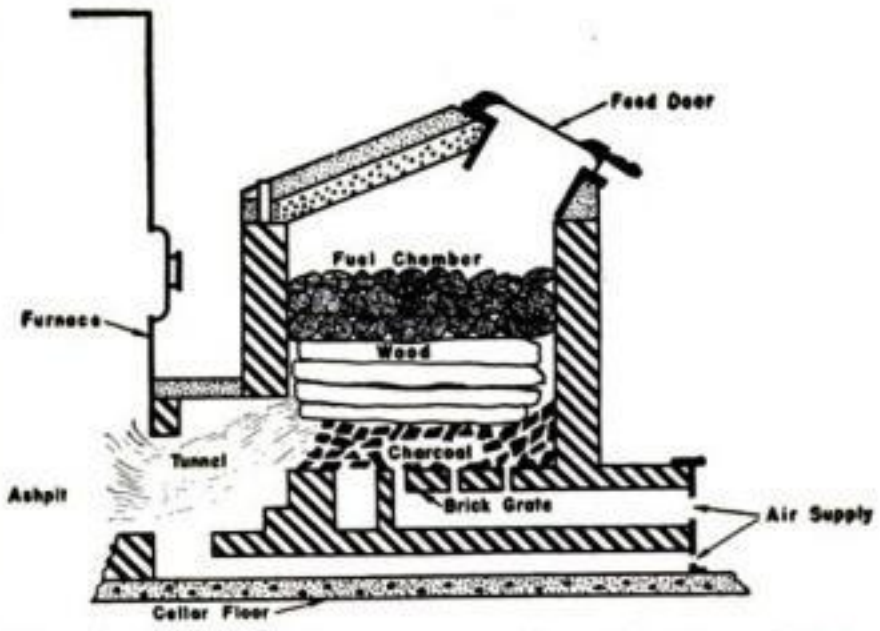


Prof. L. E. Seeley (top) and Henry Hicock with their fuel-gas unit. It's all built of firebrick

FOR home owners who can't get fuel oil but have plenty of cheap wood available, a homemade gas generator developed by the Connecticut Agricultural Experiment Station at New Haven, Conn., and the Mason Laboratory of Yale University may solve the heating problem. Designed by Prof. L. E. Seeley of the University and Henry Hicock, Assistant State Forester, the conversion unit can be built entirely of firebrick by any good mason.

Wood fed in through the top is converted into combustible gases. These, together with air drawn through draft ducts underneath the fuel chamber, are introduced into the furnace proper, where they burn at a high temperature.

William L. Slate, director of the experiment station, has announced that a special bulletin covering construction of the unit will be made available to the public.



Combustible wood gases pass through a tunnel into the furnace. Sliding doors control the air supply

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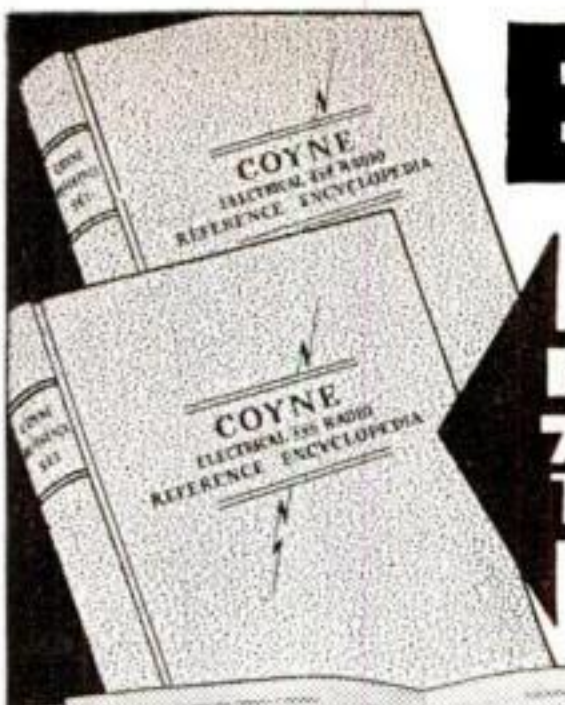

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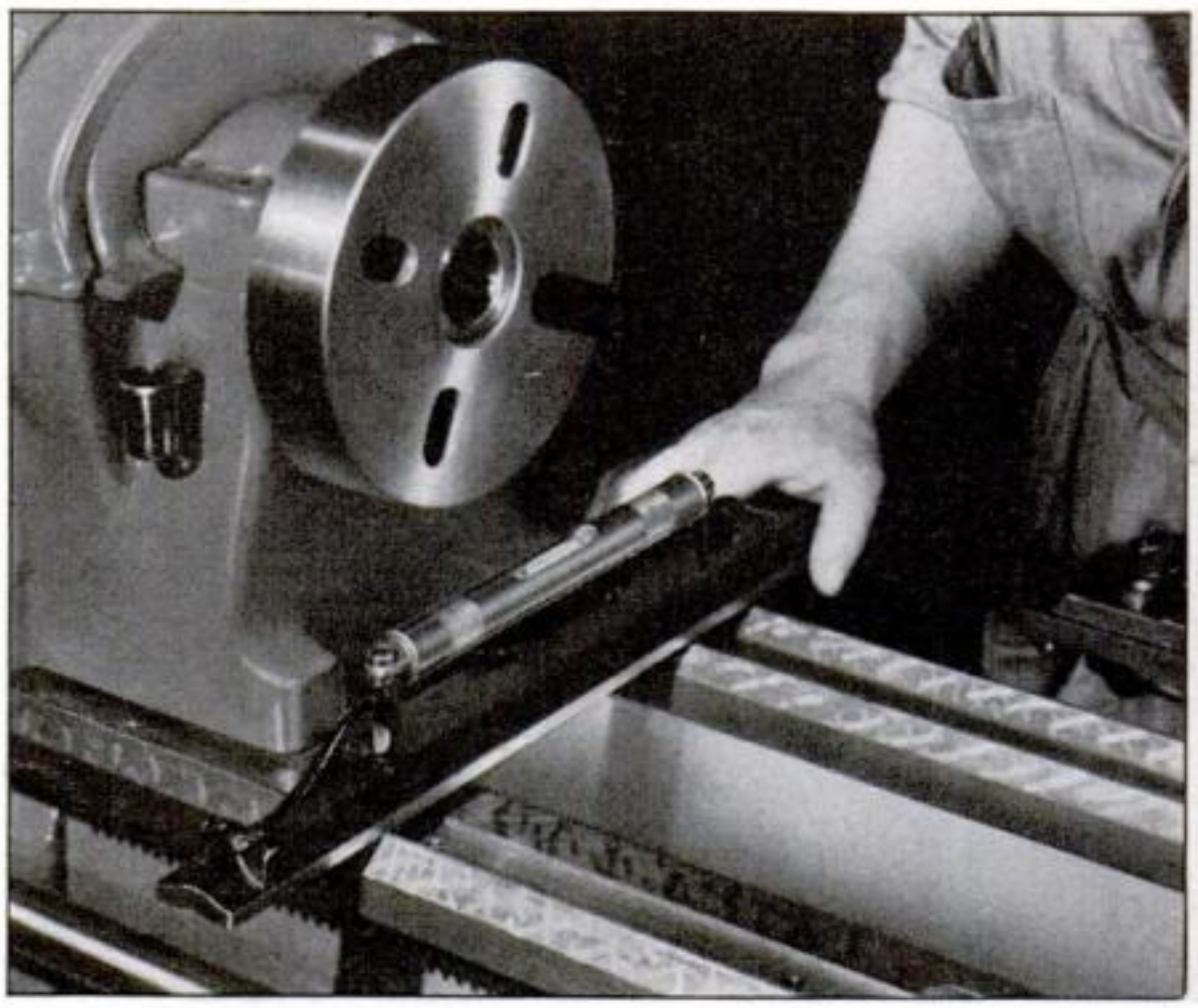
HOW TO GET THE MOST OUT OF YOUR LATHES

No. 3 in a series of suggestions made by the South Bend Lathe Works in the interest of more efficient war production

Keep Your Lathes Level

The leveling of a lathe can either perpetuate or destroy the best craftsmanship of the machine tool builder. A lathe that is not kept perfectly level cannot turn out the precision work for which it was built.

The lathe bed is comparable to a toolmaker's surface plate. Upon it rest the headstock, carriage and tailstock. Therefore, any twisting of the lathe bed will throw the headstock, tailstock and carriage out of alignment. This will cause the lathe to turn or bore a taper instead of taking a straight cut. It will also cause the alignment of the tailstock center point to shift as the tailstock is moved along the lathe bed, necessitating constant readjustment of the tailstock top set-over.



Every lathe should be checked periodically to see that it is level

Check Leveling Frequently

The major cause of distortion in lathe beds is the settling of the floor supporting the lathe. This is most commonly encountered in buildings that do not have solid foundations or that have wooden floors or columns. There are numerous other conditions which can cause this, such as the shifting of loads on the floor, swelling of wood flooring, deterioration of wooden shims, and atmospheric changes. For these reasons, every lathe should be checked periodically to see that it is level.

How to Level a Lathe

The first requisite for accurate leveling is a precision level at least 12″ long. One that is sufficiently sensitive to show a distinct movement of the bubble when a .003″ shim is placed under one end of it. A carpenter's level, a combination square level, or an ordinary machinist's level cannot be used because they are not sufficiently sensitive.

The leveling of the lathe is tested by placing the level squarely across the lathe bed, immediately in front of the headstock, and also at the extreme right end of the bed. On lathes having long beds, tests should also be made at one or more intermediate positions. Be sure that the ways are wiped perfectly clean of all chips or dirt before using the level.

Metal shims should be used under the lathe at the points indicated by the level as being low. Some lathes are equipped with leveling screws making it unnecessary to use shims.

After all adjustments have been made, bolt the lathe securely to the floor and repeat the tests to make sure that tightening the leg bolts has not affected the leveling of the lathe.

Alignment Test

A simple alignment test can be used to check the leveling of a lathe. Place a bar of steel, one inch or larger in diameter, in the chuck and machine two collars of equal diameter three or four inches apart. Then, take a very light finishing cut across both collars without changing the setting of the cutter bit. Measure both collars with a micrometer. If the collars are not the same diameter, it is an indication that the lathe is not level. Adjust the leveling until, when a cut is taken, both collars are turned the same diameter.

Write for Bulletin H3

Bulletin H3 giving more detailed information on the installation and leveling of lathes will be supplied on request. Also reprints of this and other* advertisements and bulletins in this series. State quantity.

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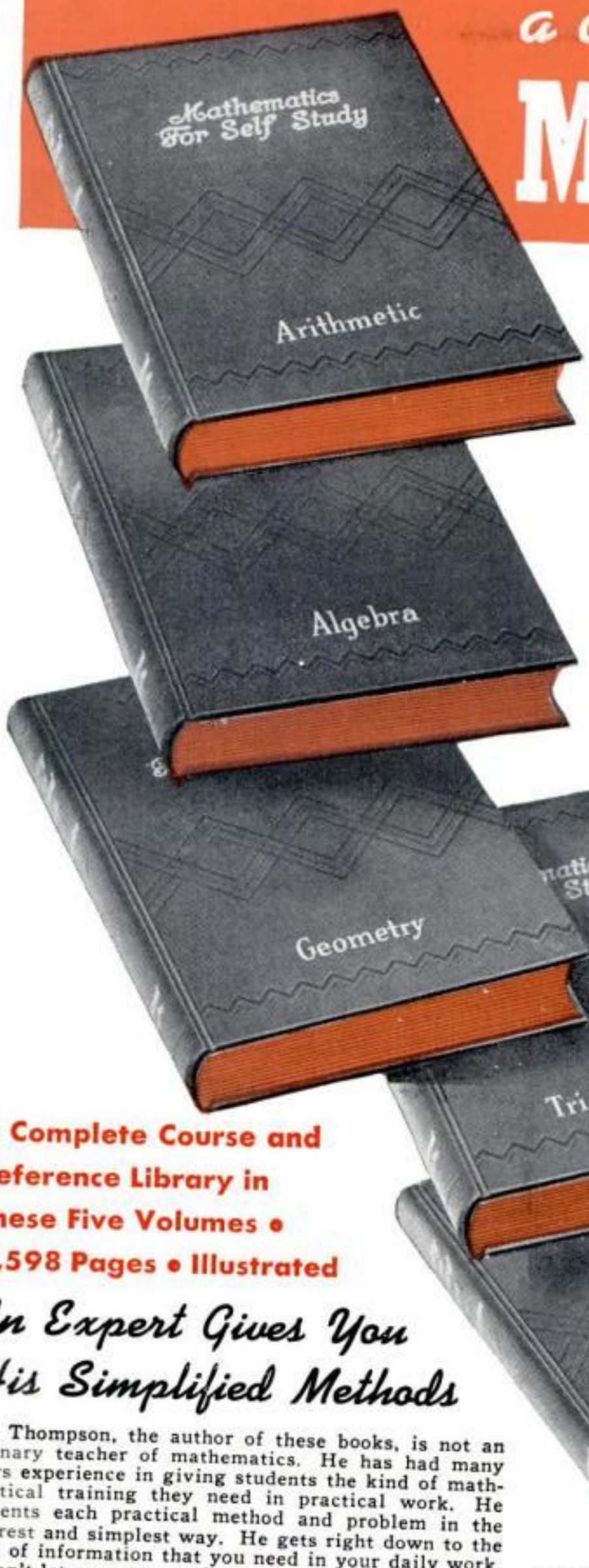

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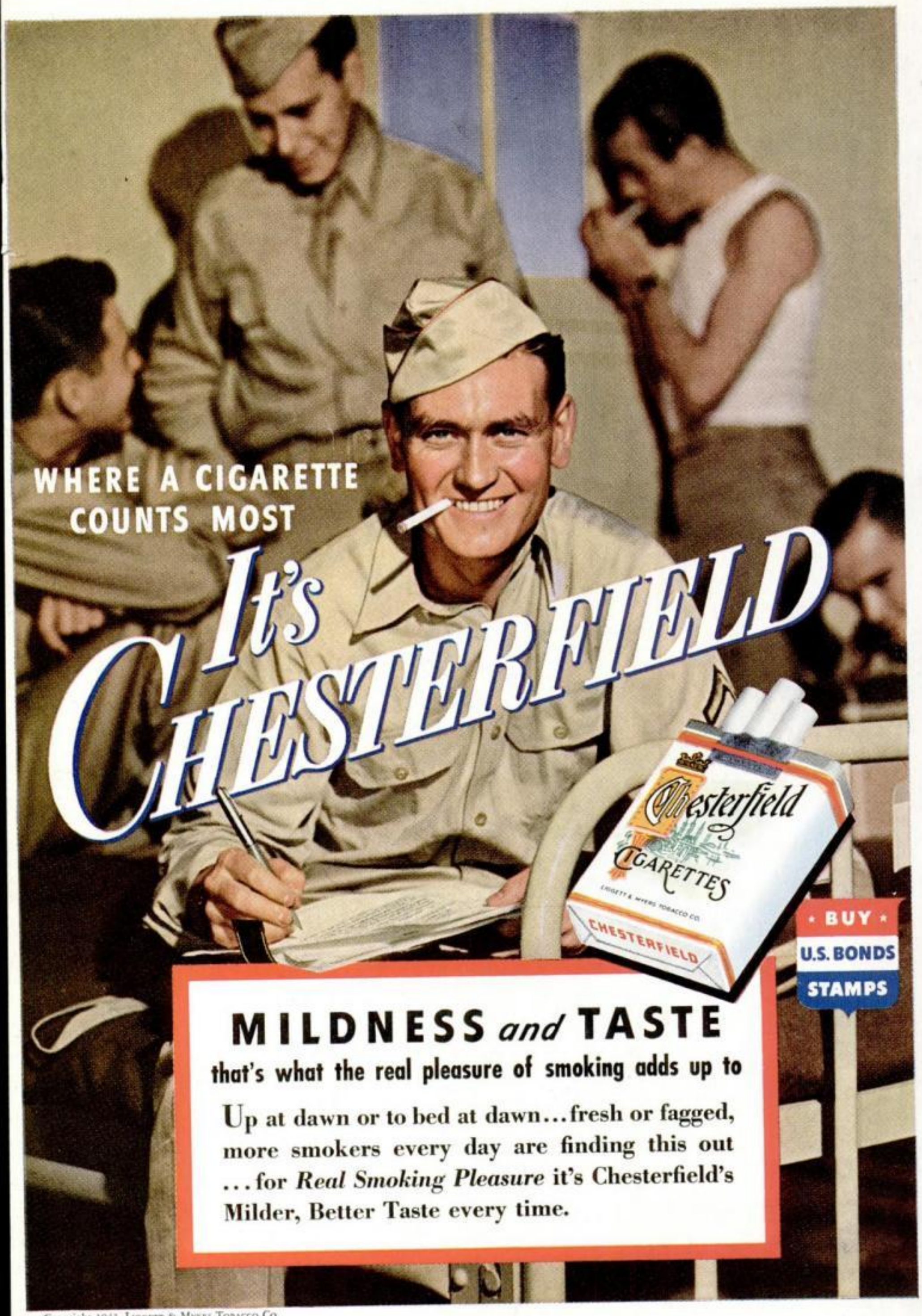

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